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**Radio Equipment and Systems (RES);
Electro-Magnetic Compatibility (EMC) for
analogue cellular radio communications equipment;
Mobile and portable equipment**

ETSI

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Foreword

This draft European Telecommunication Standard (ETS) has been produced by the Radio Equipment and Systems (RES) Technical Committee of the European Telecommunications Standards Institute (ETSI), and is now submitted for the Public Enquiry phase of the ETSI standards approval procedure.

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

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 Telecommunications Standard (ETS) covers the assessment of radio communications and ancillary equipment in respect to electromagnetic compatibility (EMC).

Technical specifications related to the antenna port and emissions from the enclosure port of radio equipment are found in the related product standards for the effective use of the radio spectrum.

This ETS specifies the applicable EMC tests, the test methods, the limits and the minimum performance criteria for analogue public cellular mobile and portable radio equipment for transmitting and receiving speech and/or data, and the associated ancillary equipment. Examples of such equipment are C450, NMT450, NMT900, Radiocom 2000 and (E)TACS.

Base station equipment is outside the scope of this ETS. However, this ETS does cover mobile and portable equipment that is intended to be operated in a fixed location while connected to the AC mains.

The environment classification used in this ETS refers to the environment classification used in the Generic Standards EN 50081-1 [1], EN 50082-1 [2], except the vehicular environment class which refers to ISO 7637 [3].

The EMC requirements have been selected to ensure an adequate level of compatibility for apparatus at residential, commercial, light industrial and vehicular 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 radio equipment to the requirements of this ETS does not signify compliance to any requirement related to the use of the equipment (i.e. licensing requirements).

Compliance to this ETS does not signify compliance to any safety requirement. 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 or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications 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 50 081-1 (1992): "Electromagnetic compatibility - Generic emission standard - Part 1: Residential, commercial and light industry".
- [2] EN 50 082-1 (1992): "Electromagnetic compatibility - Generic immunity standard - Part 1: Residential, commercial and light industry".
- [3] ISO 7 637 (1990): "Road vehicles - Electrical disturbance by conducting and coupling:

Part 1: Passenger cars and light commercial vehicles with nominal 12 V supply voltage;

Part 2: Commercial vehicles with nominal 24 V supply voltage - Electrical transient conduction along supply lines only".
- [4] EN 55 022 (1994): "Limits and methods of measurement of radio disturbance characteristics of information technology equipment".

- [5] CISPR 16-1 (1993): "Radio disturbance and immunity measuring apparatus and methods".
- [6] IEC 1 000-4-3 (1995) "Electromagnetic compatibility (EMC) - Part 4: testing and measurement techniques - Section 3: Radiated, radio-frequency, electromagnetic field immunity test".
- [7] EN 60 801-2 (1993) "Electromagnetic compatibility for industrial-process measurement and control equipment Part 2: Electrostatic discharge requirements".
- [8] IEC 1000-4-4 (1995) "Electromagnetic compatibility -Part 4: testing and measurement techniques - Section 4: Electrical fast transient/burst immunity test - Basic immunity test".
- [9] ENV 50 141 (1993): "Electromagnetic compatibility - Basic immunity standard - Conducted disturbances induced by radio-frequency fields - Immunity test".
- [10] IEC 1 000-4-11 (1994) "Electromagnetic compatibility (EMC) - Part 4: Testing and measuring techniques - Section 11: Voltage dips, short interruptions and voltage variations. Immunity tests - Basic EMC publication".
- [11] IEC 1 000-4-5 (1995) "Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 5: Surge immunity tests".

3 Definitions and abbreviations

3.1 Definitions

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

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

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

base station equipment: Mobile or portable equipment that is also intended to operate in a fixed location and powered from the AC mains.

idle mode: A mode of operation of a receiver or a transceiver, where the Equipment Under Test (EUT) is powered, available for service and available to respond to a request to set up a call.

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

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

radio communications equipment: An apparatus which includes one or more transmitters and/or receivers and/or parts thereof. This type of equipment (apparatus) can be used in a fixed, mobile or a portable application.

standby mode: Mode of operation of a transmitter, where the EUT is powered, and available for transmission on demand.

3.2 Abbreviations

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

CR	Performance criteria for Continuous phenomena applied to Receivers (subclause 6.3)
CT	Performance criteria for Continuous phenomena applied to Transmitters (subclause 6.1)
DTX	Discontinuous Transmit
emf	electromotive force
ERP	Ear Reference Point
ETS	European Telecommunication Standard
ETSI	European Telecommunications Standards Institute
EUT	Equipment Under Test
LISN	Line Impedance Stabilising Network
MRP	Mouth Reference Point
RES	Radio Equipment and Systems
rms	root mean square
RF	Radio Frequency
SPL	Sound Pressure Level
TR	Performance criteria for Transient phenomena applied to Receivers (subclause 6.4)
TT	Performance criteria for Transient phenomena applied to Transmitters (subclause 6.2)

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 configurations for emission and immunity tests as follows:

- the equipment shall be tested at a point within the specified normal operating environmental range and at the rated supply voltage for the equipment;
- 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;
- 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;
- the test conditions, test configuration and mode of operation shall be recorded in the test report;
- where portable (handheld) equipment is provided with a detachable integral antenna, it shall be tested with the antenna fitted in a manner typical of normal intended use, unless specified otherwise in this ETS;
- 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;
- ports which are not connected to cables during normal operation, e.g. service connectors, programming connectors, temporary connectors etc. shall not be connected to any cables for the purpose of EMC testing. Where cables have to be connected to these ports, or interconnecting cables have to be extended in length in order to exercise the EUT, precautions shall be taken to ensure that the evaluation of the EUT is not affected by the addition or extension of these cables;

- where the EUT employs audio companding in normal service, the unit shall have this function enabled for testing, if it is supported by the test system used to provide the communication link. Details of the methods used to establish the communications link shall be recorded in the test report;
- the test arrangements for transmitters and receivers are described separately for the sake of clarity. However, where possible the test of the transmitter section and receiver section of the EUT may be carried out simultaneously to reduce test time.

4.2 Emission tests

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

- the measurement 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 maximise the detected radiated emission for example by moving the cables of the equipment;

4.3 Immunity tests

For the immunity tests of transmitters, the transmitter shall be operated at its maximum rated output power, modulated with normal test modulation, and a communication link shall be established (subclauses 4.4, 4.5 and 4.6).

For the immunity tests of receivers, the wanted input signal, coupled to the receiver, shall be modulated with normal test modulation, and a communication link shall be established (subclauses 4.4, 4.7 and 4.8).

For the immunity tests of duplex transceivers, the wanted input signal, coupled to the receiver, shall be modulated with normal test modulation, the transmitter shall be operated at its maximum rated output power and shall be modulated with normal test modulation, and a communication link shall be established (subclauses 4.4, 4.5, 4.6, 4.7 and 4.8).

4.4 Normal test modulation

Normal test modulation shall be considered as no modulation (no audio).

The reference test peak deviation shall be two-thirds of system maximum peak deviation, or as specified in the appropriate product for performance assessment during degradation measurements. The frequency deviation of any supervisory modulation present is ignored. Examples of supervisory modulation are the SAT tone used in ETACS and phi tone used in NMT.

EXAMPLE: The reference frequency test deviation for ETACS is $\pm 6,4$ kHz ($\pm 9,5$ kHz maximum audio frequency deviation) and $\pm 3,0$ kHz for NMT ($\pm 4,7$ kHz maximum audio frequency deviation).

For the test methods RF electromagnetic field (subclause 9.1) and RF Common Mode (subclause 9.4), the test configuration shall be as follows:

- a communication link shall be set up with a suitable base station, system simulator, or production mobile tester (hereafter called "the test system"), which shall give an indication of the maintenance of the link;
- the test configuration shall be calibrated as follows:
 - the EUT shall be set to operate at the rated maximum transmit power;
 - prior to the test sequence, the level of the 1 kHz test source at the Mouth Reference Point (MRP) shall be adjusted to give the reference test frequency deviation. The demodulated audio level of the speech output signal on the uplink shall be recorded on the test instrumentation, as shown in figure 2. The audio feeding the MRP shall then be switched off. The level of the 1 kHz test source feeding the test system speech input on the downlink

signal shall be adjusted to give the reference test frequency deviation. The audio level at the Ear Reference Point (ERP) shall be recorded on the test instrumentation, as shown in figure 2. The 1 kHz test source shall then be switched off;

- the test configuration shall be operated as follows:
 - the level of the output signal from the EUT's downlink speech channel at the mobile or portable shall be assessed by measuring the Sound Pressure Level (SPL) at the ERP as shown in figure 1;
 - the level of the decoded output signal from the EUT's uplink speech channel at the analogue output of the test system shall be measured as shown in figure 1. Pick up of extraneous background noise by the EUT's microphone shall be minimised. An MRP seal may be used.

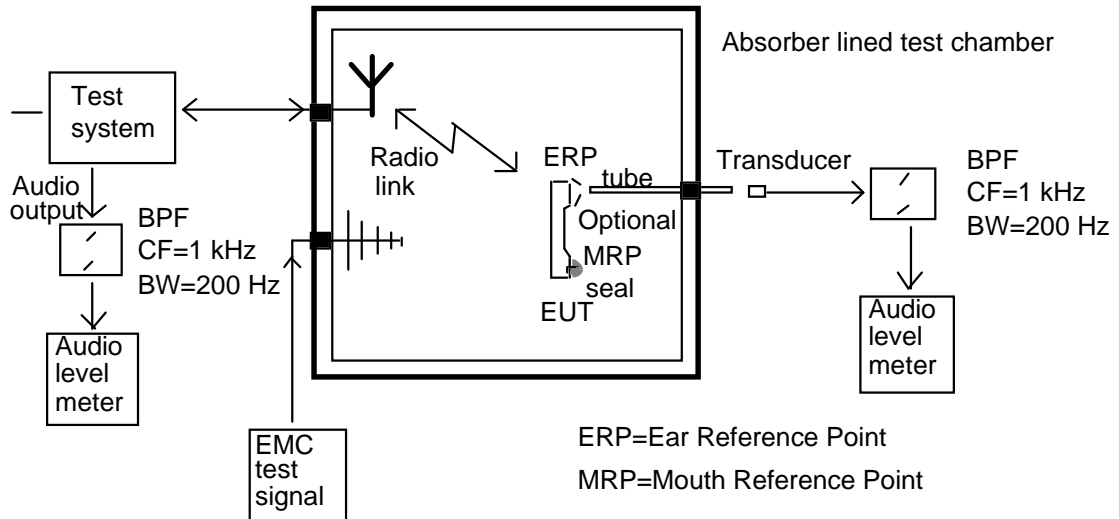
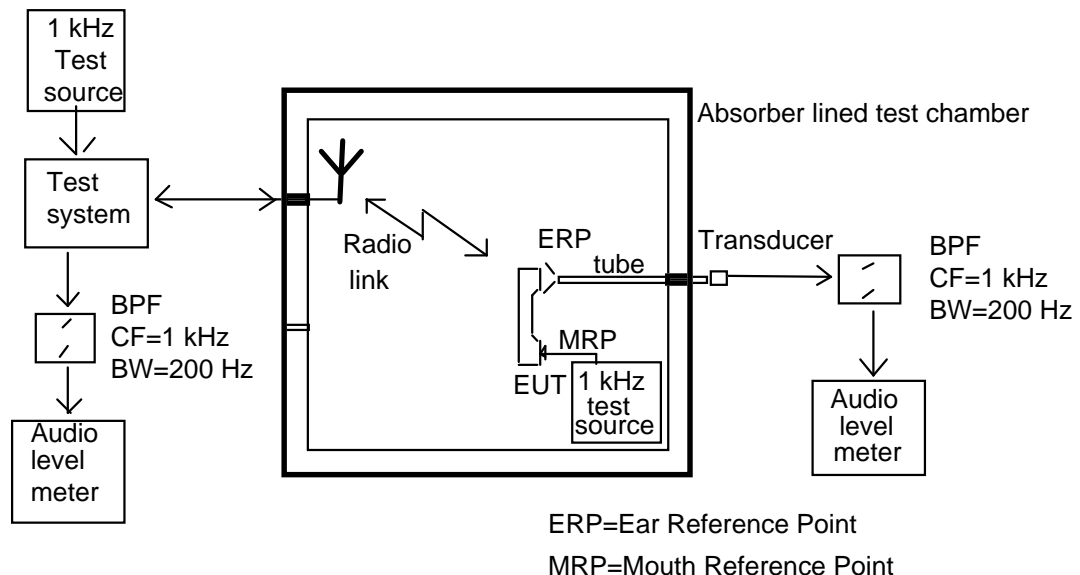


Figure 1: Audio breakthrough measurement, test set-up



NOTE: The 1 kHz MRP Test Source is in position during calibration of the uplink, but not during calibration of the downlink.

Figure 2: Audio breakthrough measurement, calibration set-up

4.5 Arrangements for test signals at the input of the transmitter

When Discontinuous Transmit (DTX) is supported by the EUT, this feature shall be disabled for the duration of the test.

A communication link shall be set up between the EUT and the test system.

4.6 Arrangements for test signals at the output of the transmitter

The test system shall be located outside of the test environment.

Where the equipment incorporates an external 50 Ω RF antenna connector that is normally connected via a coaxial cable, then the wanted signal to establish a communication link shall be delivered from that connector by a coaxial cable. Adequate measures shall be taken to avoid the effect of the unwanted signal on the measuring equipment.

Where the equipment incorporates an external 50 Ω RF antenna connector but this port is not normally connected via a coaxial cable, then the wanted signal to establish a communication link shall be delivered from that connector by a coaxial cable. Adequate measures shall be taken to avoid the effect of unwanted currents on the external conductor of the coaxial cable at the point of entry to the equipment. Adequate measures shall also be taken to avoid the effect of the unwanted signal on the measuring equipment.

Where the equipment does not incorporate an external 50 Ω RF connector (integral antenna equipment), the wanted signal, to establish a communication link, shall be delivered from the equipment to an antenna located within the test environment. Adequate measures shall be taken to avoid the effect of the unwanted signal on the measuring equipment.

4.7 Arrangements for test signals at the input of the receiver

The test system shall be located outside of the test environment.

Where the equipment incorporates an external 50 Ω RF antenna connector that is normally connected via a coaxial cable, then the wanted signal to establish a communication link shall be delivered to that connector by a coaxial cable. Adequate measures shall be taken to avoid the effect of the unwanted signal on the measuring equipment. The source of the wanted input signal shall be located outside of the test environment. The wanted input signal level shall set at a nominal value of 66 dB μ V emf unless such level causes the EUT to autonomously lower its transmit power level. If such level causes the EUT to lower its transmit power, the wanted input signal level shall be decreased to a level where the EUT returns to its maximum transmit power but no lower than 40 dB above the EUT's rated receiver sensitivity level.

Where the equipment incorporates an external 50 Ω RF antenna connector, but this port is not normally connected via a coaxial cable, then the wanted signal to establish a communication link shall be delivered from that connector by a coaxial cable. Adequate measures shall be taken to avoid the effect of unwanted currents on the external conductor of the coaxial cable at the point of entry to the equipment. Adequate measures shall also be taken to avoid the effect of the unwanted signal on the measuring equipment. The source of the wanted input signal shall be located outside of the test environment. The wanted input signal level shall set at a nominal value of 66 dB μ V emf unless such level causes the EUT to autonomously lower its transmit power level. If such level causes the EUT to lower its transmit power, the wanted input signal level shall be decreased to a level where the EUT returns to its maximum transmit power but no lower than 40 dB above the EUT's rated receiver sensitivity level.

Where the equipment does not incorporate an external 50 Ω RF connector (integral antenna equipment), the wanted signal, to establish a communication link, shall be presented to the equipment from an antenna located within the test environment. The source of the wanted input signal shall be located outside of the test environment. The wanted input signal level shall set at a nominal value of 90 dB μ V/m unless such level causes the EUT to autonomously lower its transmit power level. If such level causes the EUT to lower its transmit power, wanted input signal level shall be decreased to a level where the EUT returns to its maximum transmit power but no lower than 40 dB above the EUT's rated receiver sensitivity level.

4.8 Arrangements for test signals at the output of the receiver

The audio frequency output of the equipment may be coupled via a non-metallic acoustic tube to a suitable audio level meter outside of the test environment.

Other means of connecting the receiver output to a suitable audio level meter may be provided but shall be recorded in the test report. Precautions shall be taken to ensure that any effect on the test is minimised.

4.9 Receiver and duplex transceiver exclusion band

The exclusion band for receivers and the receivers of transceivers is the band of frequencies over which no radiated immunity tests are made.

The lower frequency of the exclusion band is the lower frequency of the receive band of the EUT minus 5 %.

The upper frequency of the exclusion band is the upper frequency of the receive band of the EUT plus 5 %.

4.10 Transmitter exclusion band

The exclusion band for transmitters extends three times the channel separation centred on the nominal operating frequency of the transmitter.

EXAMPLE: For ETACS, NMT450 and NMT900, the exclusion band is 75 kHz wide.

4.11 Narrow band responses on receivers and duplex transceivers

Responses on receivers or duplex transceivers occurring during the test at discrete frequencies which are narrow band responses (spurious responses), are identified by the following method:

- if during an immunity test the speech output signal level being monitored goes outside the specified figure, it is necessary to establish whether the speech output signal level increase is due to a narrow band response or to a wide band phenomenon. Therefore, the test shall be repeated with the unwanted signal frequency increased, and then decreased by 50 kHz;
- if the speech output signal level increase disappears in either or both of the above 50 kHz offset cases, then the response is considered as a narrow band response;
- if the speech output signal level increase does not disappear, this may be due to the fact that the offset has made the frequency of the unwanted signal correspond to the frequency of another narrow band response. Under these circumstances the procedure is repeated with the increase and decrease of the frequency of the unwanted signal set to 62,5 kHz;
- if the speech output signal level increase still does not disappear with the increased and/or decreased frequency, the phenomena is considered wide band and therefore an EMC problem and the equipment fails the test.

Narrow band responses are disregarded.

4.12 Idle Mode

When the EUT is required to be in the idle mode, the test system shall simulate a base station. The EUT shall be in a state such that it is able to respond to requests to set up a call.

EXAMPLE: An ETACS mobile equipment is synchronised to the Forward Control Channel.

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 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;
- the ancillary equipment to be combined with the radio equipment for testing (where applicable);
- the manufacturer shall at the time of submission of the equipment for test, supply information about ancillary equipment intended to be used with the radio equipment;
- an exhaustive list of ports, classified as either power or signal/control. Power ports shall further be classified as AC or DC power.

5.2 Equipment which can provide a communication 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 communication link.

5.3 Equipment which does not provide a communication link

If the equipment is of a specialised nature (subclause 6.1) which does not permit a communication link to be established or in the case of ancillary equipment tested in isolation, 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.

5.4 Conformance of 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 this ETS;
- declared compliant to an appropriate harmonised EMC standard;
- tested with it connected to a receiver, transmitter or transceiver in which case compliance shall be demonstrated to the appropriate clauses of this ETS.

5.5 Equipment classification

Portable equipment or combinations of equipment declared as capable of being powered by the battery in the vehicle shall additionally be considered as a vehicular mobile equipment.

Portable or mobile equipment or combinations of equipment declared as capable of being powered by AC mains shall additionally be considered as a base station equipment.

6 Performance criteria

The establishment and maintenance of a communications link and in the case of mobiles and portables the assessment of audio breakthrough by monitoring speech output signal level, are used as the performance criteria to ensure that all the primary functions of the transmitter and receiver are evaluated during the immunity tests.

The maintenance of a communications link shall be assessed by using an indicator which may be part of the test system or the equipment under test.

Specifically the equipment shall meet the minimum performance criteria as specified in the following subclauses as appropriate.

Portable equipment intended for use whilst powered by the main battery of a vehicle shall additionally fulfil the applicable requirements set out by this ETS for vehicular mobile equipment.

Portable or mobile equipment intended for use whilst powered by AC mains shall additionally fulfil the applicable requirements of this ETS for base station equipment, although the input/output arrangements of the equipment and the performance criteria may remain unchanged if this is more appropriate.

If an equipment is of a specialised nature, such that the performance criteria described in the following subclauses are not appropriate, then the manufacturer shall declare, for inclusion in the test report, his own specification for an acceptable level of performance or degradation of performance during and/or after testing, as required by this ETS. The performance specification shall be included in the product description and documentation. The performance criteria specified by the manufacturer shall, however, give the same degree of immunity protection as called for in the following subclauses.

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

A communication link shall be established at the start of the test, and maintained during the test, subclauses 4.5, 4.6, 4.7 and 4.8.

For mobiles and portables, the uplink and downlink speech output levels shall be at least 35 dB less than the previously recorded reference levels in the case of EUT's using audio 2:1 companding, or 18 dB less in the case of EUT's without companding. The measurement shall be performed via an audio band pass filter of width 200 Hz, centred on 1 kHz.

At the conclusion of the test the EUT shall operate as intended with no loss of user control functions or stored data, and the communication link shall have been maintained. Where the EUT is a mobile or portable, in addition to confirming the above performance during a call, the test shall also be performed in idle mode, and the transmitter shall not unintentionally operate.

Where the EUT is a transmitter only, tests shall be performed with the EUT in standby mode to ensure that unintentional transmission does not occur.

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

A communications link shall be established at the start of the test, subclauses 4.5, 4.6, 4.7 and 4.8.

At the conclusion of each exposure the EUT shall operate with no user noticeable loss of the communication link.

At the conclusion of the total test comprising the series of individual exposures the EUT shall operate as intended with no loss of user control functions or stored data, as declared by the manufacturer, and the communication link shall have been maintained.

In addition to confirming the above performance during a call, the test shall also be performed in idle mode, and the transmitter shall not unintentionally operate.

Where the EUT is a transmitter only, tests shall be performed with the EUT in standby mode to ensure that unintentional transmission does not occur.

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

A communications link shall be established at the start of the test, and maintained during the test, subclauses 4.5, 4.6, 4.7 and 4.8.

For mobiles and portables, the uplink and downlink speech output levels shall be at least 35 dB less than the previously recorded reference in the case of EUT's using audio 2:1 companding, or 18 dB less in the case of EUT's without companding. The measurement shall be performed via an audio band pass filter of width 200 Hz, centred on 1 kHz.

At the conclusion of the test the EUT shall operate as intended with no loss of user control functions or stored data, and the communication link shall have been maintained.

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

A communications link shall be established at the start of the test, subclauses 4.5, 4.6, 4.7 and 4.8.

At the conclusion of each exposure the EUT shall operate with no user noticeable loss of the communication link.

At the conclusion of the total test comprising the series of individual exposures, the EUT shall operate as intended with no loss of user control functions or stored data, as declared by the manufacturer, and the communication link shall have been maintained.

7 Applicability overview tables

7.1 Emission

Table 1: Emission applicability

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, ancillary	applicable	applicable	applicable	8.1	EN 55022 [4]
DC power input/output port	applicable	applicable	not applicable	8.2	EN 55022 [4], CISPR 16-1 [5]
AC mains input/output port	applicable	not applicable	not applicable	8.3	EN 55022 [4]

7.2 Immunity

Table 2: Immunity applicability

Phenomenon	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 electro-magnetic field (80 - 1 000 MHz)	Enclosure, radio equipment with or without ancillary equipment	applicable	applicable	applicable	9.1	IEC 1000-4-3 [6]
Electrostatic discharge	Enclosure	applicable	applicable	applicable	9.2	EN 60801-2 [7]
Fast transients common mode	Signal and control ports, DC and AC power input ports	applicable	not applicable	not applicable	9.3	IEC 1000-4-4 [8]
RF common mode 0,15 - 80 MHz	Signal and control ports, DC and AC power input ports	applicable	applicable	not applicable	9.4	ENV 50141 [9]
Transients and surges	DC power input ports	not applicable	applicable	not applicable	9.5	ISO 7637 Parts 1 and 2 [3]
Voltage dips and interruptions	AC mains power input ports	applicable	not applicable	not applicable	9.6	IEC 1000-4-11 [10]
Surges, common and differential mode	AC mains power input ports	applicable	not applicable	not applicable	9.7	IEC 1000-4-5 [11]

8 Test methods and limits for emission tests

8.1 Enclosure, ancillary equipment

This test is applicable to ancillary equipment, i.e. not connected to the radio equipment.

This test shall be performed on a representative configuration of the ancillary equipment.

8.1.1 Definition

This test assesses the ability of ancillary equipment to limit unwanted emissions from the enclosure.

8.1.2 Test method

The test method shall be in accordance with EN 55022 [4] at a 10 m measuring distance.

8.1.3 Limits

Table 3: Limits for unwanted emissions for ancillary equipment

Frequency range	Limit (quasi-peak)
30 - 230 MHz	30 dB μ V/m
> 230 - 1 000 MHz	37 dB μ V/m

8.2 DC power input/output port

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

If the DC power cable of the radio 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 of that power supply as specified in subclause 8.3.

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

8.2.1 Definition

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

8.2.2 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 Stabilising Networks (LISN) shall be connected to a DC power source.

For equipment with a current consumption above 16 A the DC power ports shall be connected to 5 μ H Line Impedance Stabilising Networks (LISN), with 50 Ω measurement ports. The LISNs shall be in accordance with the requirements of Section two of CISPR 16-1 [5].

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 [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 Section one of CISPR 16-1 [5].

8.2.3 Limits

The equipment shall meet the limits defined in this subclause (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 limits of table 4 shall apply for equipment which is not required to be connected to a local dedicated DC source.

The limits of table 5 shall apply to equipment which is required to be connected to a local dedicated DC source (i.e. which can not be connected to an extensive DC network).

Table 4: Equipment not required to be connected to a local dedicated DC source;

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

Table 5: Equipment required to be connected to a local dedicated DC source

Frequency range	Quasi-peak	Average
> 0,15-0,5 MHz	79 dB μ V	66 dB μ V
> 0,5-30 MHz	73 dB μ V	60 dB μ V

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 radio 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 [4].

8.3.3 Limits

The value of the limits shall be according to EN 55022 [4].

Table 6: Limits for conducted emissions

Frequency range	Quasi-peak	Average
> 0,15-0,5 MHz	66 - 56 dB μ V	56 - 46 dB μ V
> 0.5- 5 MHz	56 dB μ V	46 dB μ V
> 5-30 MHz	60 dB μ V	50 dB μ V
NOTE: The limit decreases linearly with the logarithm of the frequency in the range 0,15 MHz to 0,50 MHz.		

9 Test methods and levels for immunity tests

9.1 RF electro-magnetic field (80 - 1 000 MHz) with or without ancillary equipment connected

This test is applicable for base station, mobile, portable 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 electro-magnetic field disturbance at the enclosure.

9.1.2 Test method and level

The test method shall be in accordance with IEC 1000-4-3 [6] except that the following requirements shall apply:

- the test level shall be 3 V/m amplitude modulated to a depth of 80 % by a sinusoidal audio signal of 1 kHz;
- for receivers and transmitters, the stepped frequency increments shall be 1 % of the momentary frequency;
- for transmitters in transceivers with a non-continuous duty cycle the stepped frequency increments may be 10 % of the momentary frequency;
- the test shall be performed over the frequency range 80 - 1 000 MHz with the exception of an exclusion band for transmitters, subclause 4.10, and for stand alone receivers or receivers which are part of transceivers, subclause 4.9;
- responses in stand alone receivers or receivers which are part of transceivers occurring at discrete frequencies which are narrow band responses, shall be disregarded, subclause 4.11;
- the frequencies selected during the test shall be recorded in the test report.

9.1.3 Performance criteria

For transmitters the performance criteria CT, subclause 6.1, shall apply.

For stand alone receivers or receivers which are part of transceivers the performance criteria CR shall apply, subclause 6.3.

For ancillary equipment the pass/fail criteria supplied by the manufacturer 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.

9.2 Electrostatic discharge

This test is applicable for base station, mobile, portable 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 60801-2 [7].

For transmitters, receivers, transceivers and ancillary equipment the following requirements shall apply:

- for contact discharge, the equipment shall pass at ± 2 kV and ± 4 kV; for air discharge shall pass at ± 2 kV, ± 4 kV and ± 8 kV, see EN 60801-2 [7], clause 5;

9.2.3 Performance criteria

For transmitters the performance criteria TT, shall apply, subclause 6.2.

For stand alone receivers or receivers which are part of transceivers the performance criteria TR, shall apply, subclause 6.4.

For ancillary equipment the pass/fail criteria supplied by the manufacturer 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.

9.3 Fast transients common mode

This test is applicable for base station and fixed 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/output ports if the cables may be longer than 3 m.

Where this test is not carried out on any ports 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 present on one of the input/output ports.

9.3.2 Test method and level

The test method shall be in accordance with IEC 1000-4-4 [8] except that the requirements in this subclause shall apply.

For transmitters, receivers, transceivers and ancillary equipment, which have cables longer than 3 m, or are connected to the AC mains:

- the test level for signal and control ports shall be 0,5 kV open circuit voltage as given in clause 5 of IEC 1000-4-4 [8];
- the test level for DC power input/output ports shall be 1 kV open circuit voltage as given in clause 5 of IEC 1000-4-4 [8];
- the test level for AC mains power input ports shall be 2 kV open circuit voltage as given in clause 5 of IEC 1000-4-4 [8].

9.3.3 Performance criteria

For transmitters the performance criteria TT shall apply, subclause 6.2.

For stand alone receivers or receivers which are part of transceivers the performance criteria TR, shall apply, subclause 6.4.

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

9.4 RF common mode, 0,15 MHz - 80 MHz (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 input/output ports of mobile and ancillary equipment, which may have cables longer than 2 m.

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

Where this test is not carried out on any ports because the manufacturer declares that it is not intended to be used with cables longer than stated above, a list of ports which were not tested 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 electro-magnetic disturbance.

9.4.2 Test method and level

The test method shall be the current clamp injection method in accordance with ENV 50141 [9] except that the following requirements shall apply:

- the test signal shall be amplitude modulated to a depth of 80 % by a sinusoidal audio signal of 1 kHz;
- 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;
- for transmitters in transceivers with a non-continuous duty cycle the stepped frequency increments may be 500 kHz in the frequency range 150 kHz - 5 MHz and 10 % frequency increment of the momentary frequency in the frequency range 5 MHz - 80 MHz;
- the test level shall be severity level 2 as given in ENV 50141 [9] corresponding to 3 V rms, at a transfer impedance of 150 Ω ;
- no intrusive or direct connection shall be made to any of the lines of any input/output port, therefore the current clamp injection method shall be used;
- the test shall be performed over the frequency range 150 kHz - 80 MHz with the exception of an exclusion band for transmitters, subclause 4.10, and for stand alone receivers or receivers which are part of transceivers, subclause 4.9;
- responses in stand alone receivers or receivers which are part of transceivers occurring at discrete frequencies which are narrow band responses, shall be disregarded, subclause 4.11;
- the frequencies selected during the test shall be recorded in the test report.

9.4.3 Performance criteria

For transmitters the performance criteria CT shall apply, subclause 6.1.

For stand alone receivers or receivers which are part of transceivers, the performance criteria CR shall apply, subclause 6.3.

For ancillary equipment the pass/fail criteria supplied by the manufacturer 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.

9.5 Transients and surges, 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.

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

9.5.1 Definition

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

9.5.2 Test method and level

The test method shall be in accordance with ISO 7637 Part 1 [3] for 12 V DC powered equipment and ISO 7637 Part 2 [3] for 24 V DC powered equipment. The requirements are as follows:

- 1) the following requirements shall apply for 12 V DC powered equipment:
 - a) where the manufacturer in his installation documentation requires the EUT to have a direct connection to the 12 V main vehicle battery the following requirements in accordance with ISO 7637 [3] Part 1 shall apply:
 - 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:
 $V_s - 5\text{ V}, \quad V_a - 2,5\text{ V}, \quad t_6 - 25\text{ ms}, \quad t_8 - 5\text{ s}, \quad t_f - 5\text{ ms}.$
 - b) where the manufacturer does not require the EUT to have a direct connection to the 12 V main vehicle battery, the following pulses apply, in addition to the pulses in 1) a):
 - pulse 1, level II $t_1 - 2,5\text{ s},$ 10 pulses.
 - pulse 2, level II $t_1 - 2,5\text{ s},$ 10 pulses.
 - pulse 7, level II 5 pulses.

Where the manufacturer declares that the EUT requires a direct connection to the vehicle battery, and therefore the tests in accordance with 1) b) are not carried out, this shall be stated in the test report.

- 2) the following requirements shall apply for 24 V DC powered equipment:
 - a) where the manufacturer in his installation documentation requires the EUT to have a direct connection to the 24 V main vehicle battery the following requirements in accordance with ISO 7637 [3] Part 2 shall apply:
 - pulse 3a and 3b, level II, with the test time reduced to 5 min for each;
 - pulse 4, level II, 5 pulses, with the characteristics as follows:
 $V_s - 10\text{ V}, \quad V_a - 5,0\text{ V}, \quad t_6 - 25\text{ ms}, \quad t_8 - 5\text{ s}, \quad t_f - 5\text{ ms}.$
The test for this pulse 4 shall be carried out as specified in ISO 7637 [3] Part 1.
 - b) where the manufacturer does not require the EUT to have a direct connection to the 24 V main vehicle battery, the following pulses apply, in addition to the pulses in 2) a):
 - pulse 1a, level II $t_1 - 2,5\text{ s},$ $R_1 - 25,$ 10 pulses.
 - pulse 1b, level II $t_1 - 2,5\text{ s},$ $R_1 - 100,$ 10 pulses.
 - pulse 2, level II $t_1 - 2,5\text{ s},$ 10 pulses.

Where the manufacturer declares that the EUT requires a direct connection to the vehicle battery, and therefore the tests in accordance with 2) b) are not carried out, this shall be stated in the test report.

For radio and ancillary equipment designed to operate at both DC power voltages both requirement 1) and 2) shall apply.

For radio equipment designed to operate at 12 V DC power supply, but operating from a 24 V DC power adapter ancillary, then the radio equipment shall comply with the requirements in 1) and the configuration of the radio equipment and the power adapter shall comply with the requirements of 2).

9.5.3 Performance criteria

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

For stand alone receivers or receivers which are part of transceivers, pulses 3a and 3b the performance criteria CR shall apply, subclause 6.3. For pulses 1, 1a, 1b, 2, 4 and 7 the performance criteria TR shall apply, subclause 6.4, with the exception that the link need not have been maintained during exposure and may have to be re-established.

For ancillary equipment the pass/fail criteria supplied by the manufacturer 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.

9.6 Voltage dips and interruptions

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

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

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 voltage dips and interruptions present on the AC mains power input ports.

9.6.2 Test method and level

The following requirements shall apply.

The test method shall be in accordance with IEC 1000-4-11 [10].

The test levels shall be:

- a voltage dip corresponding to a reduction of the supply voltage of 30 % for 10 ms;
- a voltage dip corresponding to a reduction of the supply voltage of 60 % for 100 ms;
- a voltage interruption corresponding to a reduction of the supply voltage of > 95 % for 5 000 ms.

9.6.3 Performance criteria

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

- for transmitters the performance criteria CT, subclause 6.1;
- for stand alone receivers or receivers which are part of transceivers the performance criteria CR, subclause 6.3;
- for ancillary equipment the pass/fail criteria supplied by the manufacturer 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.

For a voltage dip corresponding to a reduction of the supply voltage of 60 % for 100 ms and/or a voltage interruption corresponding to a reduction of the supply voltage of > 95 % for 5 000 ms the following performance criteria shall apply:

- in the case where the equipment is fitted with or connected to a battery back-up the performance criteria TT, subclause 6.2, or TR, 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) the communications link need not be maintained and may have to be re-established and volatile user data may have been lost.

In the event of loss of the communications link or in the event of loss of user data, this fact shall be recorded in the test report, the product description and the user documentation.

9.7 Surges, common and differential mode

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

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

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

9.7.1 Definition

These tests assess the ability of transmitters, receivers, transceivers and ancillary equipment to operate as intended in the event of surges being present at the AC mains power input ports.

9.7.2 Test method and level

The following requirements shall apply.

The test method shall be in accordance with IEC 1000-4-5 [11].

The test level shall be 1 kV open circuit voltage for line-to-ground and 0,5 kV open circuit voltage for line-to-line.

9.7.3 Performance criteria

For transmitters the performance criteria TT shall apply, subclause 6.2.

For stand alone receivers or receivers which are part of transceivers the performance criteria TR shall apply, subclause 6.4.

For ancillary equipment the pass/fail criteria supplied by the manufacturer 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.

History

Document history			
May 1996	Public Enquiry WITHDRAWN	PE 106:	1996-05-20 to 1996-09-13
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