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**Radio Equipment and Systems (RES);
Electro-Magnetic Compatibility (EMC) for
European digital cellular telecommunications system
(GSM 900 MHz and DCS 1 800 MHz)
Part 1: Mobile and portable radio and ancillary equipment**

ETSI

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Foreword

This European Telecommunication Standard (ETS) has been prepared by the Radio Equipment and Systems (RES) Technical Committee of the European Telecommunications Standards Institute (ETSI).

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

This ETS is based upon the Generic Standards EN 50081-1 [1], EN 50082-1 [2], ETS 300 339 [3], and other standards where appropriate, to meet the essential requirements of the Council Directive 89/336/EEC [4].

Every ETS prepared by ETSI is a voluntary standard. This ETS contains text which may be used for regulatory purposes. This text does not make this ETS mandatory in its status as a standard. However, the ETS can be referenced, wholly or in part, for mandatory application by decisions of regulatory bodies.

This ETS is in two (2) parts to reflect those requirements for Terminal Equipment and non-Terminal Equipment as follows:

Part 1: Mobile and portable radio and ancillary equipment

Part 2: Base station radio and ancillary equipment

Transposition dates	
Date of latest announcement of this ETS (doa):	28 February 1995
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1 Scope

This European Telecommunication Standard (ETS) covers the assessment of radio communication and ancillary equipment in respect of Electro-Magnetic Compatibility, and may be used to demonstrate presumption of compliance with the protection requirements of the Council Directive 89/336/EEC [4], Article 4.

This ETS specifies the applicable EMC tests, the methods of measurement, the frequency range, the limits and the minimum performance criteria for GSM 900 MHz and DCS 1 800 MHz digital public cellular mobile and portable radio equipment, transmitting and receiving speech and/or data, and the associated ancillary equipment.

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 [5].

For the purposes of this ETS, Mobile Stations (MS) are considered to be radio communications equipment.

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 50081-1 (1992): "Electromagnetic compatibility - Generic emission standard. Part 1: Residential, commercial and light industry".
- [2] EN 50082-1 (1992): "Electromagnetic compatibility - Generic immunity standard. Part 1: Residential, commercial and light industry".
- [3] Draft prETS 300 339: "Radio Equipment and Systems (RES); General Electro-Magnetic Compatibility (EMC) for radio equipment".
- [4] 89/336/EEC (1989): "Council Directive on the approximation of the laws of the Member States relating to electromagnetic compatibility".
- [5] ISO 7637 (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".

- [6] GSM 05.08/GSM 05.08-DCS-1800: "European digital cellular telecommunications system; Radio Subsystem Link Control".
- [7] EN 55022: "Limits and methods of measurement of radio interference characteristics of information technology equipment".
- [8] CISPR Publication No. 16-1: "Specification for radio disturbance and immunity measuring apparatus and methods".
- [9] ENV 50140: "Basic immunity standard - Radiated, radio frequency, electromagnetic fields".
- [10] IEC 801-2 (second edition 1991) Part 2: "Electrostatic discharge requirements".
- [11] IEC 801-4 (1988) Part 4: "Electrical fast transients / burst requirements".
- [12] ENV 50141: "Basic immunity standard - Conducted disturbances induced by radio-frequency fields".
- [13] IEC 1000-4-11: "Voltage dips, short interruptions and voltage variations. Immunity tests".
- [14] IEC 1000-4-5: "Surge immunity requirements".

3 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: Portable or mobile equipment also intended for normal use whilst powered by ac mains supply.

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.

manufacturer: The legal entity responsible under the terms of the Council Directive, 89/336/EEC [4], for placing the product on the market.

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.

RXQUAL: A measure of the received signal quality, which is generated by the mobile or portable equipment, for use as a criterion in the RF power control and handover processes. For more information see GSM 05.08 [6], subclause 8.2.

4 General test conditions

4.1 Test conditions

The equipment shall be tested under normal test conditions contained in the relevant product and basic standards or in the information accompanying the equipment, which are within the manufacturers declared range of humidity, temperature, and supply voltage.

The test conditions shall be recorded in the test report.

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

Whenever the EUT is provided with a detachable antenna, the EUT shall be tested with the antenna fitted in a manner typical of normal intended use.

The test set ups for transmitters and receivers are described separately for the sake of clarity. However, it is not necessarily excluded that the test of the transmitter section and receiver section of the EUT can be carried out simultaneously to reduce test time.

4.2 Test conditions for immunity tests

For the immunity tests of transmitters, the transmitter shall be operated at its maximum rated output power, up to and not exceeding a maximum of 20 W, modulated with normal test modulation (see subclauses 4.3 and 4.4). A communication link shall be established (see subclause 4.5).

For the immunity tests of receivers, the wanted input signal, coupled to the receiver, shall be modulated with normal test modulation (see subclauses 4.3 and 4.6). A communication link shall be established (see subclause 4.7).

For the immunity tests of duplex transceivers, the wanted input signal, coupled to the receiver, shall be modulated with normal test modulation (see subclauses 4.3 and 4.6). The transmitter shall be operated at its maximum rated output power, up to and not exceeding a maximum of 20 W. A communication link shall be established (see subclause 4.5).

4.3 Normal test modulation for mobile and portable equipment

The wanted RF input signal nominal frequency shall be selected by setting the Absolute Radio Frequency Channel Number (ARFCN) to an appropriate number, e.g. in the case of GSM 900 MHz this will be 60 to 65.

A communication link shall be set up with a suitable base station, system simulator, or production mobile tester (hereafter called "the test system").

When the EUT is required to be in the transmit/receive mode, the following conditions shall be met:

- the EUT shall be commanded to operate at maximum transmit power (not exceeding 20 W);
- the downlink RXQUAL shall be monitored;
- prior to the test sequence, the reference level of the speech output signal on both the downlink and uplink shall be recorded on the test instrumentation, as shown in figure 2. The reference level shall be equivalent to 0 dBPa at 1 kHz at the Ear Reference Point (ERP) for the downlink, and - 5 dBPa at 1 kHz at the Mouth Reference Point (MRP) for the uplink;
- the level of the output signal from the EUT's downlink speech channel at the mobile or portable's ear piece shall be assessed by measuring the Sound Pressure Level (SPL) 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. Pick up of extraneous background noise by the EUT's microphone shall be minimised.

NOTE: In the case of equipment not containing analogue speech circuits, the assessment of speech signal level is not applicable.

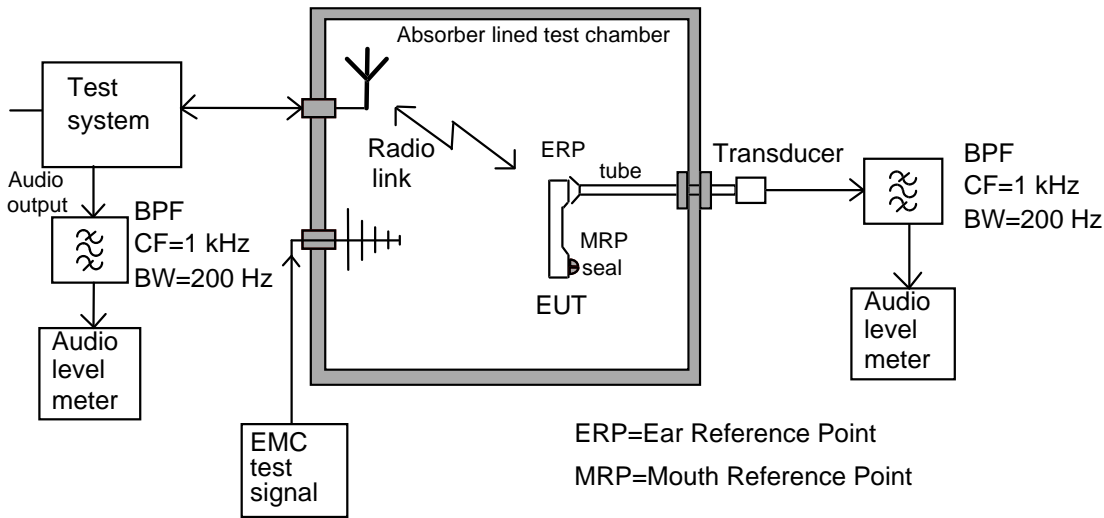
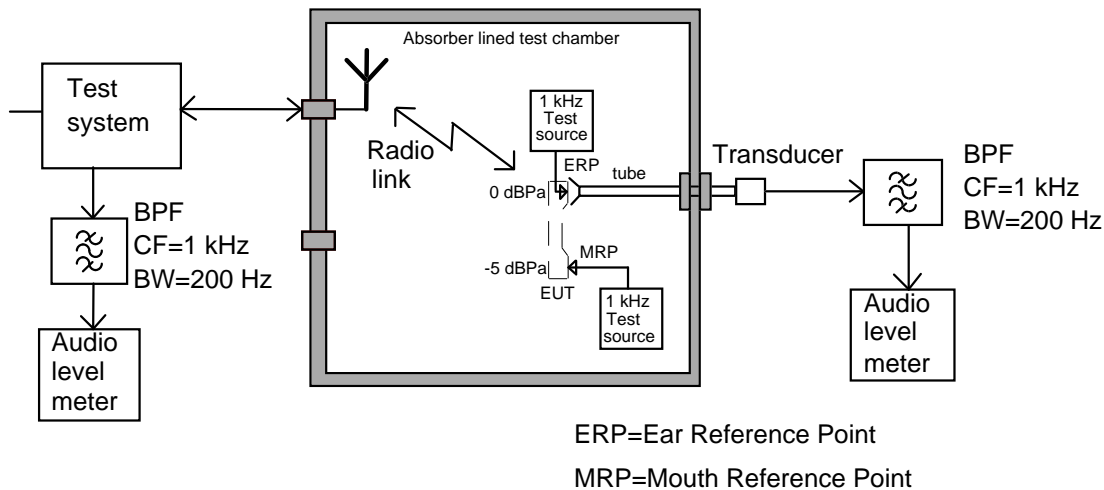


Figure 1: Audio breakthrough measurement, test set-up



NOTE: The EUT is in position during calibration of the uplink, but not during calibration of the downlink.

Figure 2: Audio breakthrough measurement, calibration set-up

When the EUT is required to be in the idle mode, the test system shall simulate a BS with Broadcast Control Channel/Common Control Channel (BCCH/CCCH) on one carrier. The EUT shall be synchronised to the BCCH, listening to the CCCH and able to respond to paging messages.

4.4 Arrangements for test signals at the input of the transmitter

For mobiles and portables the test system shall command the EUT to disable Discontinuous Transmission (DTX).

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

4.5 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, the wanted signal, to establish a communication link shall be delivered from that connector by a coaxial cable. Adequate measures shall be taken to minimise 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.

4.6 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, the wanted signal, to establish a communication link shall be presented to that connector by a coaxial cable. Adequate measures shall be taken to minimise the effect of unwanted currents on the external conductor of the coaxial cable at the point of entry to the equipment. The source of the wanted input signal shall be located outside of the test environment and shall be at a nominal value of 66 dB μ V emf.

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, and shall be at a nominal value of 90 dB μ V/m. The source of the wanted input signal shall be located outside of the test environment.

4.7 Arrangements for test signals at the output of the receiver

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

Where it is not practical to use a non metallic tube, then other means of connecting the receiver output to a suitable audio level meter shall be provided and recorded in the test report. Precautions shall be taken to ensure that any effect on the test is minimised.

4.8 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 6 %.

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

4.9 Transmitter exclusion band

The exclusion band for transmitters extends \pm 200 kHz from the nominal operating frequency of the transmitter.

4.10 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 RXQUAL or speech output signal level being monitored goes outside the specified figure, it is necessary to establish whether the RXQUAL increase or 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 400 kHz;

- if the RXQUAL increase or speech output signal level increase disappears in either or both of the above 400 kHz offset cases, then the response is considered as a narrow band response;
- if the RXQUAL increase or 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 500 kHz;
- if the RXQUAL increase or 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.

5 Performance assessment

5.1 General

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:

- any primary functions of the radio equipment additional to those specified in clause 6, as requested by the manufacturer, to be tested during and after the EMC testing;
- the intended functions of the EUT 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;
- the ancillary equipment submitted for test on a stand alone basis, not combined 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.

If the equipment is a radio equipment of a non-specialised nature or a radio equipment combined with an ancillary equipment, the test modulation, test arrangement etc. as required in clause 4 shall apply.

In the case of ancillary equipment tested on a stand alone basis and/or radio equipment of a specialised nature, see clause 6, 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 shall also provide the following information:

- the pass/fail criteria for the EUT;
- the method of observing a degradation of performance of the equipment.

The degradation of performance assessment which shall be carried out during and/or at the conclusion of the tests, shall be simple, but at the same time give adequate proof that the essential functions of the equipment are operational.

An ancillary equipment may, at the manufacturer's discretion, be declared compliant separately from a receiver, transmitter or transceiver to all the applicable immunity and emission clauses of this ETS.

Alternatively, at the manufacturer's discretion, an ancillary equipment may be declared compliant to another harmonised EMC standard.

Either way, this compliance may enable the ancillary equipment to be used with different receivers, transmitters or transceivers.

An ancillary equipment may, at the manufacturer's discretion, be tested with it connected to a receiver, transmitter or transceiver during the tests, in which case compliance shall be demonstrated to the appropriate clauses of this ETS.

5.2 Equipment classification

Portable equipment also intended for normal use whilst powered by the main battery of the vehicle shall additionally be considered as a vehicular mobile equipment.

Portable or mobile equipment also intended for normal use whilst powered by ac mains shall additionally be considered as a base station equipment.

6 Performance criteria

The establishment and maintenance of a communications link, the assessment of RXQUAL, 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.

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

A portable equipment intended for use whilst powered by the battery in a vehicle shall fulfil the applicable requirements set out by this ETS for vehicular mobile equipment.

A portable or mobile equipment intended for use whilst powered by ac mains shall 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 communications link shall be established at the start of the test, and maintained during the test, see subclauses 4.5 and 4.6.

For mobiles and portables, the uplink and downlink speech output levels shall be at least 35 dB less than the previously recorded reference levels, when measured through 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, see subclauses 4.5 and 4.6.

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 must 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, see subclauses 4.5 and 4.6.

For mobiles and portables RXQUAL of the downlink shall not exceed three (3), measured during each individual exposure in the test sequence.

For mobiles and portables, the uplink and downlink speech output levels shall be at least 35 dB less than the previously recorded reference levels, when measured through 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, see subclauses 4.5 and 4.6.

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 clause 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 for ancillary equipment not integrated into receivers, transmitters or transceivers	applicable for ancillary equipment not integrated into receivers, transmitters or transceivers	applicable for ancillary equipment not integrated into receivers, transmitters or transceivers	8.2	EN 55022 [7]
DC power in/out	applicable	applicable	not applicable	8.3	EN 55022 [7], CISPR 16-1 [8]
AC mains	applicable	not applicable	not applicable	8.4	EN 55022 [7]

7.2 Immunity

Table 2: Immunity applicability

Phenomena	Application	Equipment test requirement			Reference clause 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	applicable	applicable	applicable	9.2	ENV 50140 [9]
Electrostatic discharge	Enclosure	applicable	applicable	applicable	9.3	IEC 801-2 [10]
Fast transients common mode	Signal and control ports, dc and ac power input ports	applicable	not applicable	not applicable	9.4	IEC 801-4 [11]
RF common mode 0,15 - 80 MHz (current clamp injection)	Signal and control ports, dc and ac power ports	applicable	applicable	not applicable	9.5	ENV 50141 [12]
Transients and surges, vehicular environment	DC power input ports	not applicable	applicable	not applicable	9.6	ISO 7637 Parts 1 and 2 [5]
Voltage dips and interruptions	AC mains power input ports	applicable	not applicable	not applicable	9.7	IEC 1000-4-11 [13]
Surges, common and differential mode	AC mains power input ports	applicable	not applicable	not applicable	9.8	IEC 1000-4-5 [14]

8 Test methods and limits for emission tests of transmitters and/or receivers and/or ancillary equipment

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;
- the equipment shall be configured in a manner which is representative of a normal/typical operation, where practical;
- an attempt shall be made to maximise 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;
- the configuration and mode of operation during measurements shall be precisely noted in the test report;

- 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 tested;
- ports which in normal operation are connected shall be connected to an ancillary equipment or to a representative piece of cable terminated to simulate the impedance of the ancillary equipment. RF input/output ports shall be correctly terminated;
- the tests shall be carried out at a point within the specified normal operating environmental range and at the rated supply voltage for the equipment.

8.2 Enclosure - ancillary equipment

This test is applicable to ancillary equipment not integrated into a receiver, transmitter, or transceiver.

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

8.2.1 Definition

This test assesses the ability of ancillary equipment to limit any spurious radiation from the enclosure.

8.2.2 Test method

The test method shall be in accordance with EN 55022 [7].

8.2.3 Limits

Class B limits shall be according to EN 55022 [7] shown in table 3 (10 m measuring distance).

Table 3: Limits for spurious radiation (Class B)

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

8.3 DC power input/output port

This test is applicable for base station, mobile and ancillary equipment which may have dc cables longer than 3 m.

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

8.3.1 Definition

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

8.3.2 Test method

The dc power ports shall be connected to 5 μ H Line Impedance Stabilising Networks (LISNs), with 50 Ω impedance measurement ports. The LISNs shall be in accordance with the requirements of CISPR Publication No. 16-1 [8].

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 [7] 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 Publication No. 16-1 [8].

8.3.3 Limits for conducted RF signals

The equipment shall meet the limits in table 4 (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 receiver is unnecessary.

Table 4: Limits for conducted RF signals

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

8.4 AC mains power input/output port

This test is applicable for base station and fixed ancillary equipment, powered by the ac mains.

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

8.4.1 Definition

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

8.4.2 Test method

The test method shall be in accordance with EN 55022 [7].

8.4.3 Limits

The limits shall be Class B according to EN 55022 [7] shown in table 5.

Table 5: Limits for conducted RF signals (Class B)

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 frequency in the range 0,15 MHz to 0,50 MHz.

9 Test methods and levels for immunity tests of transmitters and/or receivers and/or ancillary equipment

9.1 Test configuration

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

- the measurement shall be made in the operational mode as required in subclause 4.1;
- if the equipment is part of a system, or can be connected to ancillary equipment, then it shall be acceptable to test the equipment connected to the minimum representative configuration of ancillary equipment necessary to exercise the ports;

- for the immunity tests of ancillary equipment, without a separate pass/fail criteria, the receiver, transmitter or transceiver coupled to the ancillary equipment shall be used to judge whether the ancillary equipment passes or fails;
- the configuration and mode of operation during measurements shall be precisely noted in the test report;
- if the equipment has a large number of ports, then a sufficient number shall be selected to simulate actual operational conditions and to ensure that all the different types of termination are covered;
- ports which in normal operation are connected, shall be connected to an ancillary equipment or to a representative piece of cable terminated to simulate the impedance of the ancillary equipment. RF input/output ports shall be correctly terminated;
- the tests shall be carried out at a point within the specified normal operating environmental range and at the rated supply voltage for the equipment.

9.2 RF electro-magnetic field (80 - 1 000 MHz)

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 presence of a radio frequency electro-magnetic field disturbance.

9.2.2 Test method and level

The test method shall be in accordance with ENV 50140 [9] 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, see subclause 4.9, and for stand alone receivers or receivers which are part of transceivers, see subclause 4.8;
- responses in stand alone receivers or receivers which are part of transceivers occurring at discrete frequencies which are narrow band responses, shall be disregarded, see subclause 4.10;
- the frequencies selected during the test shall be recorded in the test report.

9.2.3 Performance criteria

For transmitters the performance criteria CT, see subclause 6.4, shall apply.

For stand alone receivers or receivers which are part of transceivers the performance criteria CR shall apply, see subclause 6.6.

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 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.

9.3.1 Definition

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

9.3.2 Test method and level

The test method shall be in accordance with IEC 801-2 [10].

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 IEC 801-2 [10], clause 5;
- electrostatic discharges shall be applied to all exposed surfaces of the EUT except where the user documentation specifically indicates a requirement for appropriate protective measures, see IEC 801-2 [10], subclause 8.3.1.

9.3.3 Performance criteria

For transmitters the performance criteria TT, shall apply, see subclause 6.5.

For stand alone receivers or receivers which are part of transceivers the performance criteria TR, shall apply, see subclause 6.7.

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.

9.4 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 three (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 three (3) m, a list of ports which were not tested for this reason shall be included in the test report.

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

9.4.1 Definition

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

9.4.2 Test method and level

The test method shall be in accordance with IEC 801-4 [11] except that the following requirements shall apply.

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

- the test level for signal and control ports shall be severity level 2 corresponding to 0,5 kV open circuit voltage as given in clause 5 of IEC 801-4 [11];
- the test level for dc power input/output ports shall be severity level 2 corresponding to 1 kV open circuit voltage as given in clause 5 of IEC 801-4 [11];
- the test level for ac mains power input ports shall be severity level 3 corresponding to 2 kV open circuit voltage as given in clause 5 of IEC 801-4 [11].

For ac input and dc power input/output ports the transients shall be applied (in parallel) to all the wires in the cable with reference to the cabinet reference ground, i.e. line-to-ground, (true common mode), with a source impedance of 50 Ω .

9.4.3 Performance criteria

For transmitters the performance criteria TT shall apply, see subclause 6.5.

For stand alone receivers or receivers which are part of transceivers the performance criteria TR, shall apply, see subclause 6.7.

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.

9.5 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 two (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 one (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 two (2) m (mobile and ancillary equipment) or one (1) m (base station and fixed ancillary), 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.

9.5.1 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 on the input/output ports.

9.5.2 Test method and level

The test method shall be the current clamp injection method in accordance with ENV 50141 [12] 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 [12] 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, see subclause 4.7, and for stand alone receivers or receivers which are part of transceivers, see subclause 4.6;
- responses in stand alone receivers or receivers which are part of transceivers occurring at discrete frequencies which are narrow band responses, shall be disregarded, see subclause 4.8;
- the frequencies selected during the test shall be recorded in the test report.

9.5.3 Performance criteria

For transmitters the performance criteria CT shall apply, see subclause 6.4.

For stand alone receivers or receivers which are part of transceivers, the performance criteria CR shall apply, see subclause 6.6.

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 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 volt and 24 volt 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.

9.6.1 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.

9.6.2 Test method and level

The test method shall be in accordance with ISO 7637 Part 1 [5] for 12 volt dc powered equipment and ISO 7637 Part 2 [5] for 24 volt dc powered equipment.

- 1) The following requirements shall apply for 12 volt dc powered equipment:
 - a) where the manufacturer in his installation documentation requires the EUT to have a direct connection to the 12 volt main vehicle battery the following requirements in accordance with ISO 7637 [5] Part 1 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:

$$V_s - 5 \text{ V}, \quad V_a - 2,5 \text{ V}, \quad t_6 - 25 \text{ ms}, \quad t_8 - 5 \text{ s}, \quad t_f - 5 \text{ ms}.$$

- b) where the manufacturer does not require the EUT to have a direct connection to the 12 volt main vehicle battery, the following pulses apply, in addition to the pulses in 1) a):
- | | | |
|---------------------|-------------|------------|
| - pulse 1, level II | t1 - 2,5 s, | 10 pulses. |
| - pulse 2, level II | t1 - 2,5 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 volt dc powered equipment:

- a) where the manufacturer in his installation documentation requires the EUT to have a direct connection to the 24 volt main vehicle battery the following requirements in accordance with ISO 7637 [5] 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 [5] Part 1.

- b) where the manufacturer does not require the EUT to have a direct connection to the 24 volt main vehicle battery, the following pulses apply, in addition to the pulses in 2) a):
- | | | | |
|----------------------|-------------|---------------------|------------|
| - pulse 1a, level II | t1 - 2,5 s, | Ri - 25 Ω , | 10 pulses. |
| - pulse 1b, level II | t1 - 2,5 s, | Ri - 100 Ω , | 10 pulses. |
| - pulse 2, level II | t1 - 2,5 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 volt dc power supply, but operating from a 24 volt 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).

9.6.3 Performance criteria

For transmitters, pulses 3a and 3b, the performance criteria CT shall apply, see subclause 6.4. For pulses 1, 1a, 1b, 2, 4 and 7 the performance criteria TT shall apply, see subclause 6.5, 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, see subclause 6.6. For pulses 1, 1a, 1b, 2, 4 and 7 the performance criteria TR shall apply, see subclause 6.7, 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.

9.7 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.

9.7.1 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.

9.7.2 Test method and level

The following requirements shall apply.

The test method shall be in accordance with IEC 1000-4-11 [13].

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.

9.7.3 Performance criteria

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

- for transmitters the performance criteria CT, see subclause 6.4;
- for stand alone receivers or receivers which are part of transceivers the performance criteria CR, see subclause 6.6;
- 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 the following performance criteria shall apply:

- for transmitters the performance criteria TT, see subclause 6.5;
- for stand alone receivers or receivers which are part of transceivers the performance criteria TR, see subclause 6.7;
- 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, see subclause 6.5, or TR, see subclause 6.7, 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.

9.8 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.

9.8.1 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.

9.8.2 Test method and level

The following requirements shall apply.

The test method shall be in accordance with IEC 1000-4-5 [14]:

- the test level shall be severity level 2 corresponding to 1 kV open circuit voltage for line-to-ground and severity level 2 corresponding to 0,5 kV open circuit voltage for line-to-line;
- the transients shall be applied (in parallel) to all the wires in the cable with reference to the cabinet reference ground, for line-to-ground tests, i.e. true common mode, with a series resistance of 10 Ω .

9.8.3 Performance criteria

For transmitters the performance criteria TT shall apply, see subclause 6.5.

For stand alone receivers or receivers which are part of transceivers the performance criteria TR shall apply, see subclause 6.7.

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	
November 1994	First Edition
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