



EUROPEAN
TELECOMMUNICATION
STANDARD

ETS 300 342-1

June 1997

Second Edition

Source: ETSI TC-RES

Reference: RE/RES-09035-1

ICS: 33.020

Key words: DCS, EMC, GSM, radio, testing

**Radio Equipment and Systems (RES);
ElectroMagnetic 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 produced by the European Telecommunications Standards Institute (ETSI) in response to a mandate from the European Commission issued under Council Directive 83/189/EEC (as amended) laying down a procedure for the provision of information in the field of technical standards and regulations.

This ETS is intended to become a Harmonized Standard, the reference of which will be published in the Official Journal of the European Communities referencing the Council Directive on the approximation of the laws of the Member States relating to electromagnetic compatibility ("the EMC Directive") (89/336/EEC as amended).

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

This ETS consists of 3 parts as follows:

Part 1: "Mobile and portable radio and ancillary equipment";

Part 2: "Base station radio and ancillary equipment (Phase 1)" (RE/RES-09035-2);

Part 3: "Base station radio and ancillary equipment (Phase 2)" (DE/RES-09035-3).

Transposition dates	
Date of adoption:	6 June 1997
Date of latest announcement of this ETS (doa):	30 September 1997
Date of latest publication of new National Standard or endorsement of this ETS (dop/e):	31 March 1998
Date of withdrawal of any conflicting National Standard (dow):	31 March 1998

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1 Scope

This second edition European Telecommunication Standard (ETS) covers the assessment of radio communication and ancillary equipment in respect of 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 methods of measurement, the frequency range, the limits and the minimum performance criteria for Phase 1 and Phase 2 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.

Base station equipment operating within network infrastructure 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 Part 1 [3] and Part 2 [4].

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 in 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 and informative 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] ISO 7637-1 (1990): "Road vehicles - Electrical disturbance by conduction and coupling - Part 1: Passenger cars and light commercial vehicles with nominal 12 V supply voltage - Electrical transient conduction along supply lines only".
- [4] ISO 7637-2 (1990): "Road vehicles - Electrical disturbance by conduction and coupling - Part 2: Commercial vehicles with nominal 24 V supply voltage - Electrical transient conduction along supply lines only".

- [5] I-ETS 300 034-1 (1993-10): "European digital cellular telecommunications system (Phase 1); Radio sub-system link control (GSM 05.08)".
- [6] I-ETS 300 034-2 (1993-9): "European digital cellular telecommunications system (Phase 1); Radio sub-system link control Part 2: DCS extension (GSM 05.08-DCS)".
- [7] ETS 300 578 Edition 6 (1996-8): "Digital cellular telecommunications system (Phase 2); Radio subsystem link control (GSM 05.08)".
- [8] EN 55022 (1994): "Limits and methods of measurement of radio disturbance characteristics of information technology equipment".
- [9] CISPR 16-1 (1993): "Specification for radio disturbance and immunity measuring apparatus and methods - Part 1: Radio disturbance and immunity measuring apparatus".
- [10] EN 61000-4-3: "Electromagnetic Compatibility (EMC) - Part 4: Testing and measurements techniques - Section 3: Radiated, radio-frequency, electromagnetic field immunity test".
- [11] EN 61000-4-2: "Electromagnetic Compatibility (EMC) - Part 4: Testing and measurements techniques - Section 2: Electrostatic discharge immunity test. Basic EMC publication".
- [12] EN 61000-4-4: "Electromagnetic Compatibility (EMC); Part 4: Testing and measurements techniques - Section 4: Electrical fast transient/burst immunity test. Basic EMC publication".
- [13] EN 61000-4-6: "Electromagnetic Compatibility (EMC) - Part 4: Testing and measurements techniques - Section 6: Immunity to conducted disturbances induced by radio-frequency fields".
- [14] EN 61000-4-11: "Electromagnetic Compatibility (EMC); Part 4: Testing and measurements techniques - Section 11: Voltage dips, short interruptions and voltage variations immunity tests".
- [15] EN 61000-4-5: "Electromagnetic Compatibility (EMC) - Part 4: Testing and measurements techniques - Section 5: Surge immunity test".

3 Definitions, symbols 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.

RXQUAL: A measure of the received signal quality, which is generated by the mobile or portable equipment, for use as a criterion in the Radio Frequency (RF) power control and handover processes. For more information see:

- I-ETS 300 034-1 [5] subclause 8.2 for Phase 1 GSM 900 equipment;
- I-ETS 300 034-2 [6] subclause 8.2 for Phase 1 DCS 1800 equipment; or
- ETS 300 578 Edition 6 [7] subclause 8.2 for Phase 2 GSM 900 or Phase 2 DCS 1800 equipment.

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

3.2 Symbols

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

AC	Alternating Current
DC	Direct Current
BPF	BandPass Filter
BW	BandWidth
CF	Centre Frequency
emf	electromotive force
rms	root mean square
RXQUAL	RX Quality

3.3 Abbreviations

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

ARFCN	Absolute Radio Frequency Channel Number
BCCH	Broadcast Control Channel
BS	Base Station
CCCH	Common Control CHannel
CR	Continuous phenomena applied to Receivers (subclause 6.3)
CT	Continuous phenomena applied to Transmitters (subclause 6.1)
DTX	Discontinuous Transmission
EMC	ElectroMagnetic Compatibility
ERP	Ear Reference Point
EUT	Equipment Under Test
LISN	Line Impedance Stabilizing Network
MRP	Mouth Reference Point
MS	Mobile Station
RF	Radio Frequency
SPL	Sound Pressure Level
TR	Transient phenomena applied to Receivers (subclause 6.4)
TT	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 under normal test conditions as specified in the product standard;
- 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 input/output characteristics 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;
- 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 measurements

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 maximize 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

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 is 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;
- 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. Set the EUT volume to provide nominal audio level if specified by the manufacturer. If no such level is specified, the centre volume step shall be used;
- 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 minimized.

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

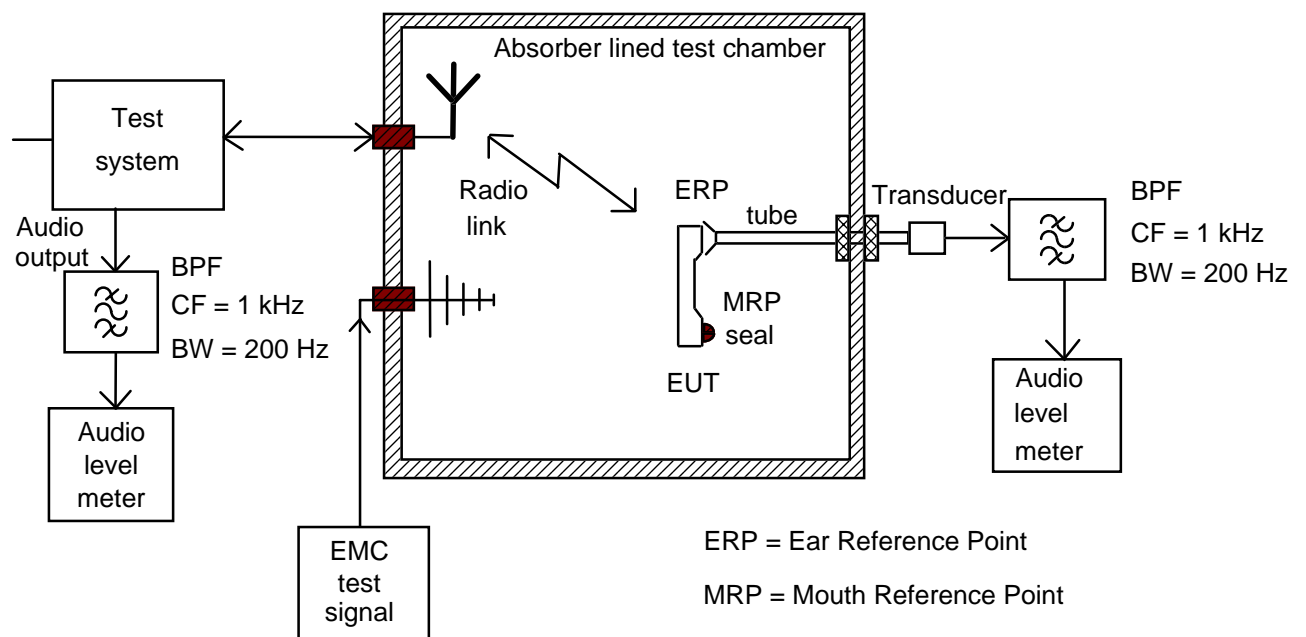
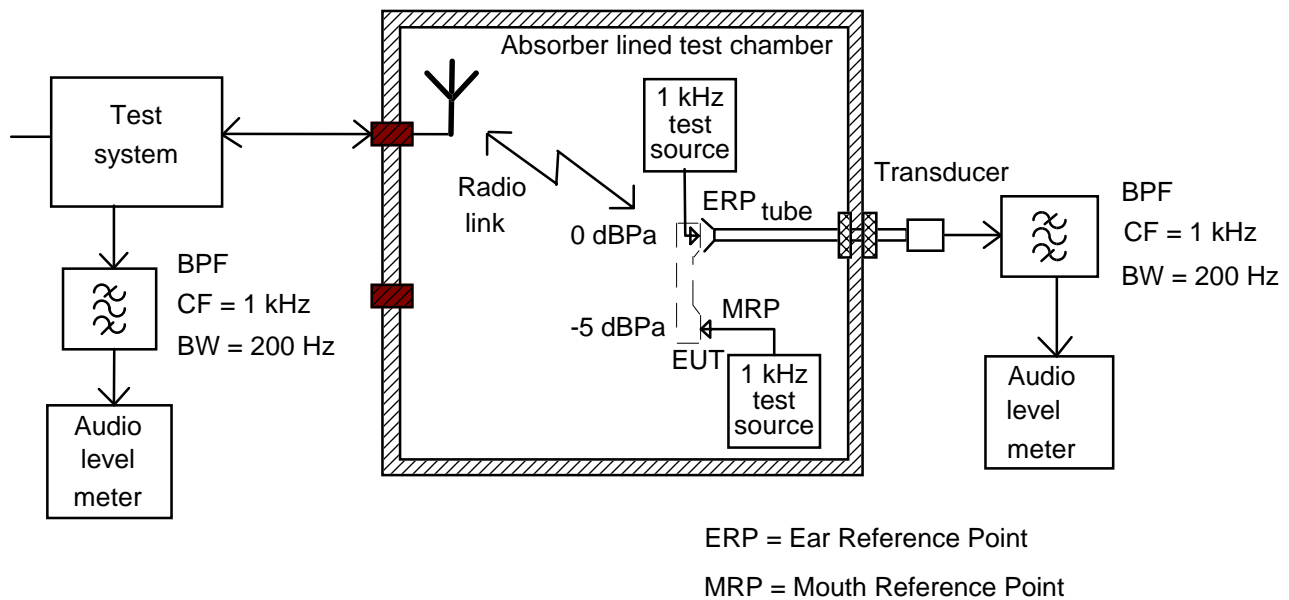


Figure 1: Audio breakthrough measurement, test set-up



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

4.5 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.

4.6 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 be set at a nominal value of 66 dBμV emf.

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 be set 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. The source of the wanted input signal shall be located outside of the test environment. The wanted input signal level shall be set at a nominal value of 90 dB μ V emf.

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 minimized.

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 6 %.

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 (3×200 kHz = 600 kHz) centred on the nominal operating frequency of the transmitter.

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 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.

4.12 Idle Mode

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

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;
- the volume settings shall be recorded in the test report.

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 specialized nature which does not permit a communication link (subclause 6.1) 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 harmonized EMC standard;
- tested with it connected to a receiver, transmitter or transceiver in which case compliance shall be demonstrated to the appropriate clauses of 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, 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. In addition, the test shall also be performed in idle mode for transceivers or standby mode for transmitters only, to ensure the transmitter does not unintentionally operate.

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 specialized 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.

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, 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, 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 RXQUAL of the downlink shall not exceed three, 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, 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 standard
	Base station and ancillary equipment for fixed use	Mobile and ancillary equipment for vehicular use	Portable and ancillary equipment for portable use		
Enclosure of ancillary	applicable	applicable	applicable	8.1	EN 55022 [8]
DC power input/output port	applicable	applicable	not applicable	8.2	EN 55022 [8], CISPR 16-1 [9]
AC mains input/output port	applicable	not applicable	not applicable	8.3	EN 55022 [8]

7.2 Immunity

Table 2: Immunity applicability

Phenomenon	Application	Equipment test requirement			Reference subclause in this ETS	Reference standard
		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	9.1	EN 61000-4-3 [10]
Electrostatic discharge	Enclosure	applicable	applicable	applicable	9.2	EN 61000-4-2 [11]
Fast transients common mode	Signal and control ports, DC and AC power input ports	applicable	not applicable	not applicable	9.3	EN 61000-4-4 [12]
RF common mode 0,15 - 80 MHz	Signal and control ports, DC and AC power input ports	applicable	applicable	not applicable	9.4	EN 61000-4-6 [13]
Transients and surges, vehicular environment	DC power input ports	not applicable	applicable	not applicable	9.5	ISO 7637 Part 1 [3] and Part 2 [4]
Voltage dips and interruptions	AC mains power input ports	applicable	not applicable	not applicable	9.6	EN 61000-4-11 [14]
Surges, common and differential mode	AC mains power input ports	applicable	not applicable	not applicable	9.7	EN 61000-4-5 [15]

8 Test methods and limits for emission measurements

8.1 Enclosure, ancillary equipment

This test is applicable to ancillary equipment not incorporated into the radio communications equipment. When the ancillary equipment is tested with the radio equipment, radiated emissions from the transmitter/transceiver shall be ignored but recorded in the test report.

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 [8] 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 intended to be less than 3 m in length, and intended only for direct connection to a dedicated AC to DC power supply, then the measurement shall be performed only 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 [8] and the Line Impedance Stabilizing Networks (LISN) shall be connected to a DC power source.

For equipment with a current consumption above 16 A the DC power ports shall be connected to 5 μ H LISN, with 50 Ω measurement ports. The LISNs shall be in accordance with the requirements of section two of CISPR 16-1 [9].

In the case of DC output ports, the ports shall be connected via a LISN to a load drawing the rated current of the source.

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

The equipment shall be installed with a ground plane as defined in EN 55022 [8]. 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 [9].

8.2.3 Limits

The equipment shall meet the limits defined 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 8.2.2 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.

Table 4: Limits

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.		

8.3 AC mains power input/output port

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

This test is not applicable to AC output ports which are connected directly (or via a switch or circuit breaker) to the AC input port.

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 [8].

8.3.3 Limits

The value of the limits shall be according to EN 55022 [8].

Table 5: 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 electromagnetic 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.

9.1.1 Definition

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

9.1.2 Test method and level

The test method shall be in accordance with EN 61000-4-3 [10] 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;
- the stepped frequency increments shall be 1 % of the momentary frequency;
- the test shall be performed over the frequency range 80 MHz- 1 000 MHz with the exception of 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 61000-4-2 [11].

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 61000-4-2 [11].

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 a port or any other 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 EN 61000-4-4 [12] 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 EN 61000-4-4 [12];
- the test level for DC power input/output ports shall be 1 kV open circuit voltage as given in EN 61000-4-4 [12];
- the test level for AC mains power input ports shall be 2 kV open circuit voltage as given in EN 61000-4-4 [12].

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 a port or any other 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.

NOTE: This test can also be performed using the intrusive method, where appropriate, see EN 61000-4-6 [13].

9.4.1 Definition

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

9.4.2 Test method and level

The test method should be the current clamp injection method in accordance with EN 61000-4-6 [13]. Alternatively, an intrusive or direct connection may be made to any of the lines of any input/output port where it is practical and the performance of the equipment is not degraded.

The test method shall be in accordance with EN 61000-4-6 [13] 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;
- the stepped frequency increments shall be 50 kHz in the frequency range 150 kHz - 5 MHz and 1 % frequency increment of the momentary frequency in the frequency range 5 MHz - 80 MHz;
- the test level shall be severity level 2 as given in EN 61000-4-6 [13] corresponding to 3 V rms, at a transfer impedance of 150 Ω ;
- the test shall be performed over the frequency range 150 kHz - 80 MHz;
- 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 and the test method used 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 7637-1 [3] for 12 V DC powered equipment and ISO 7637-2 [4] 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 7637-1 [3] 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 $t_1 = 2,5 \text{ s}, \quad 10 \text{ pulses};$
 - pulse 2, level II $t_1 = 2,5 \text{ s}, \quad 10 \text{ pulses}.$

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 7637-2 [4] 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:
 $V_s = 10 \text{ V}, \quad V_a = 5,0 \text{ V}, \quad t_6 = 25 \text{ ms}, \quad t_8 = 5 \text{ s}, \quad t_f = 5 \text{ ms}.$
The test for this pulse 4 shall be carried out as specified in ISO 7637-1 [3].
 - 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 $t_1 = 2,5 \text{ s}, \quad R_i = 25, \quad 10 \text{ pulses};$
 - pulse 1b, level II $t_1 = 2,5 \text{ s}, \quad R_i = 100, \quad 10 \text{ pulses};$
 - pulse 2, level II $t_1 = 2,5 \text{ s}, \quad 10 \text{ pulses}.$

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 TT shall apply, subclause 6.2. For pulses 1, 1a, 1b, 2 and 4 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, with the exception that the audio breakthrough test is not performed (the 1kHz level is not monitored). For pulses 1, 1a, 1b, 2 and 4 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 EN 61000-4-11 [14].

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 TT, subclause 6.2;
- for stand alone receivers or receivers which are part of transceivers the performance criteria CR, subclause 6.3, with the exception that the audio breakthrough test is not performed (the 1kHz level is not monitored);
- 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, shall 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 performance criteria TT, subclause 6.2, or TR, subclause 6.4, apply as appropriate. However, the communications link need not be maintained and may have to be re-established and volatile user data may have been lost;
- 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.

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 EN 61000-4-5 [15].

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.

Annex A (normative): Clauses and/or subclauses addressing essential requirements of EC Council Directives

Table A.1: Clauses and/or subclauses addressing essential requirements of EC Council Directives

Clause/subclause number and title		Corresponding article of Council Directive 89/336/EEC	Qualifying remarks
8	Test methods and limits for emission measurements		
8.1	Enclosure, ancillary equipment	4(a)	
8.2	DC power input/output port	4(a)	
8.3	AC mains power input/output port	4(a)	
9	Test methods and levels for immunity tests		
9.1	RF electromagnetic field (80 - 1 000 MHz)	4(b)	
9.2	Electrostatic discharge	4(b)	
9.3	Fast transient common mode	4(b)	
9.4	RF common mode, 0,15 MHz - 80 MHz (current clamp injection)	4(b)	
9.5	Transient and surges, vehicular environment	4(b)	
9.6	Voltage dips and interruptions	4(b)	
9.7	Surges common and differential mode	4(b)	

History

Document history	
November 1994	First Edition
January 1997	One-step Approval Procedure OAP 9722: 1997-01-31 to 1997-05-30
June 1997	Second Edition