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Candidate Harmonized European Standard (Telecommunications series)

**Electromagnetic compatibility
and Radio spectrum Matters (ERM);
ElectroMagnetic Compatibility (EMC) standard
for ground-based Very High Frequency (VHF) hand-held,
mobile and fixed radio transmitters, receivers
and transceivers for the VHF aeronautical mobile service**



Reference

DEN/ERM-EMC-029

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ETSI

Postal address

F-06921 Sophia Antipolis Cedex - FRANCE

Office address

650 Route des Lucioles - Sophia Antipolis
Valbonne - FRANCE
Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16
Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
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Internet

secretariat@etsi.fr
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Foreword

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

The present document has been produced by ETSI in response to a mandate from the European Commission issued under Council Directive 98/34/EC [18] (as amended) laying down a procedure for the provision of information in the field of technical standards and regulations.

The present document, together with EN 300 676 [17] , 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 [1] as amended).

The present document is intended to become a Harmonized Standard, the reference of which will be published in the Official Journal of the European Communities referencing the Directive 98/13/EC [19] of the European Parliament and of the Council relating to telecommunications terminal equipment and satellite earth station equipment, including the mutual recognition of their conformity ("Directive 98/13/EC [19] ").

Technical specifications relevant to Directive 98/13/EC [19] are given in annex A.

For equipment which can be connected to the AC main supply, the requirements of EN 61000-3-2 [15] and EN 61000-3-3 [16] apply where appropriate from 1-1-2001.

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

Introduction

The present document defines the testing required to prove compliance with the EMC directive 89/336/EEC [1] for ground base station, mobile and hand held applications of AM VHF aeronautical radios. It also covers EMC requirements for VDL Mode 2 base station radio equipment.

The EMC requirements have been selected to ensure an adequate level of compatibility for apparatus within aerodrome, en route, vehicular and hand held/portable operational environments. The levels, however, do not cover extreme cases which may occur in any location but with a low probability of occurrence.

Compliance of radio equipment with the requirements of the present document does not signify compliance with any requirements related to the use of the equipment, for example licensing requirements.

Compliance with the requirements of the present document does not signify compliance with any safety requirements. However, the assessor of the equipment should record in the report any observations regarding the test sample becoming dangerous or unsafe as a result of the application of the tests called for in the present document.

The present document is based on the considerations and guidance given in ETR 238 [12].

1 Scope

The present document covers the assessment of ground base station, ground mobile and hand held/portable aeronautical VHF radio communication and ancillary equipment in respect of EMC.

The present document also covers EMC requirements for VDL Mode 2 ground base station radio equipment.

The present document specifies the applicable EMC tests, the methods of measurements, the limits and the minimum performance criteria for radio equipment and any associated ancillary equipment:

- a) operating in the frequency range 118 MHz to 136,975 MHz, at 8,33 kHz or 25 kHz channel spacing;
- b) using DSB AM. or D8PSK modulation;
- c) for ground base station, mobile or hand held/portable applications.

However, it does not specify general methods of measurement related to the antenna port. These are contained in EN 300 676 [17].

The EMC requirements have been selected to ensure an adequate level of compatibility for apparatus within aerodrome, en route, vehicular and hand held/portable operational environments. The levels, however, do not cover extreme cases which may occur in any location but with low probability of occurrence.

Compliance of radio equipment to the requirements of the present document does not signify compliance to any requirements related to the use of the equipment, for example licensing requirements.

Compliance to the requirements of the present document does not signify compliance to any safety requirements. However, it is the responsibility of the assessor of the equipment to record in the test report any observations regarding the test sample becoming dangerous or unsafe as a result of the application of the tests called for in the present document.

The present document is based on the considerations and guidance given in ETR 238 [12].

2 References

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

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

- [1] 89/336/EEC: "Council Directive on the approximation of the laws of the Member States relating to electromagnetic compatibility".
- [2] 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".
- [3] 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".
- [4] EN 55022: "Limits and methods of measurement of radio interference characteristics of information technology equipment".

- [5] CISPR 16-1: "Specification for radio disturbance and immunity measuring apparatus and methods - Part 1: Radio disturbance and immunity measuring apparatus".
- [6] EN 61000-4-2: "Electro-magnetic compatibility for industrial process measurement and control equipment". Part 2: Electrostatic discharge requirements.
- [7] EN 61000-4-3: "Electro-magnetic compatibility - Part 4: testing and measurement techniques - Section 3: Radiated, radio frequency electro-magnetic field immunity test".
- [8] EN 61000-4-4: "Electro-magnetic compatibility - Part 4: testing and measurement techniques - Section 4: Electrical fast transient/burst immunity test - Basic immunity test".
- [9] EN 61000-4-5: "Electro-magnetic compatibility - Part 4: Testing and measurement techniques; Section 5: Surge immunity tests".
- [10] EN 61000-4-6: "Basic immunity standard - Conducted disturbances induced by radio-frequency fields".
- [11] EN 61000-4-11: "Voltage dips, short interruptions and voltage variations: immunity tests".
- [12] ETR 238: "ETSI/CENELEC standardization programme for the development of Harmonized Standards related to Electro-Magnetic Compatibility (EMC) in the field of telecommunications".
- [13] ITU-R Radio Regulations 1 - 18 clause 146 (1994)
- [14] ETR 028: "Radio Equipment and Systems (RES); Uncertainties in the measurement of mobile radio equipment characteristics".
- [15] EN 61000-3-2: "Limits for harmonic current emissions".
- [16] EN 61000-3-3: "Limits of voltage fluctuations and flicker in low-voltage supply systems for equipment with rated current $\leq 16A$ ".
- [17] EN 300 676: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Radio transmitters and receivers at aeronautical stations of the aeronautical mobile service operating in the VHF band (118 MHz to 137 MHz) using amplitude modulation 25 kHz and 8,33 kHz channel spacing; Technical characteristics and methods of measurement".
- [18] 98/34/EC: "Council Directive laying down a procedure for the provision of information in the field of technical standards and regulations".
- [19] 98/13/EC: "Council Directive relating to telecommunications terminal equipment and satellite earth station equipment, including the mutual recognition of their conformity".

3 Definitions and abbreviations

3.1 Definitions

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

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

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

integral antenna equipment: radio communications equipment with an antenna integrated into the equipment without the use of an external connector and considered to be part of the equipment. An integral antenna may be internal or external to the equipment. In equipment of this type, a 50Ω RF connection point shall be provided for test purposes.

non-integral antenna equipment: radio communications equipment with a connector intended for connection to an antenna.

base station: aeronautical station equipment, in the aeronautical mobile service, for use with an external antenna and intended for use at a fixed location.

mobile: radio equipment designed for installation into vehicles.

hand held: radio equipment with integral batteries, designed to be hand portable and operated hand held. Provisions may be made for external connections and temporary installation into vehicles.

manufacturer (supplier): legal entity responsible under the terms of the Council Directive 89/336/EEC [1] for placing the product on the market in a member state of the European Union.

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

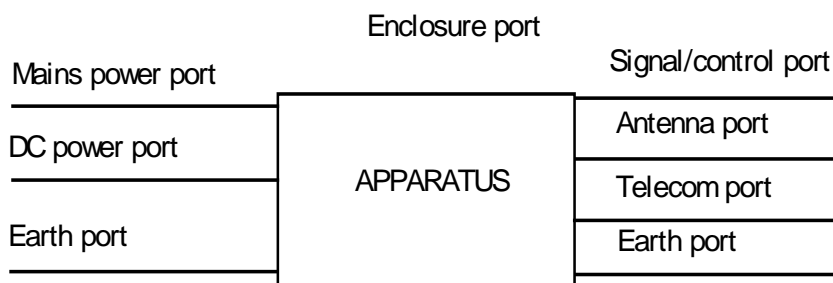


Figure 1: Examples of ports

necessary bandwidth: for a given class of emission, the width of the frequency band which is just sufficient to ensure the transmission of information at the rate and with the quality required under specified conditions (ITU-R Radio Regulations [13], clause 146).

occupied bandwidth: width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to a specified percentage $b/2$ of the total mean power of a given emission. Unless otherwise specified by ITU-R for the appropriate class of emission, the value of $b/2$ should be taken as 0,5 % (ITU-R Radio Regulations [13]).

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

simplex: instantaneous one-way communications link.

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

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

operating frequency range: range(s) of continuous radio frequencies covered by the (Equipment Under Test) EUT.

enclosure port: physical boundary of the equipment onto which an electromagnetic phenomenon may radiate or impinge.

3.2 Abbreviations

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

AC	Alternating Current
AM	Amplitude Modulation
AMN	Artificial Mains Network
B	Measurement Bandwidth
BER	Bit Error Rate
D8PSK	Differentially Encoded 8 Phase Shift Keying
DC	Direct Current
DSB	Double SideBand full carrier
EM	ElectroMagnetic
EMC	ElectroMagnetic Compatibility
EUT	Equipment Under Test

F_c Centre of transmitter necessary bandwidth

LISN	Line Impedance Stabilizing Network
PEP	Peak Envelope Power
RF	Radio Frequency
rms	root mean of squares

4 General test conditions

4.1 Test conditions and configurations

The Equipment Under Test (EUT) 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 manufacturer's declared range of humidity, temperature and supply voltage.

The test configuration shall represent normal intended use.

The EUT shall be tested in a manner as close as possible to normal intended use, consistent with the requirements of the present document. In order to perform particular tests which could not be performed otherwise, special test software or hardware may be used. However, such special software or hardware shall cause repeatable test results which are representative of normal operational conditions.

Where the EUT is provided with a detachable integral antenna, it shall be tested with the antenna replaced with a 50 Ω termination or connected to 50 Ω test equipment.

If the EUT is part of a system, or can be connected to ancillary equipment, then the EUT may be tested while connected to the minimum representative configuration of ancillary equipment necessary to exercise the ports and functionality.

Ports which in normal operation can be connected to ancillary or other equipment through interconnecting cables shall either be connected to such equipment via a representative interconnecting cable, or to a representative termination to simulate the input/output characteristics of the ancillary or other equipment via a representative interconnecting cable. RF input/output ports shall be correctly terminated.

If the EUT 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 are not connected to cables during normal intended operation, for example service connectors, programming connectors or temporary connectors, 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 performance of the EUT is not affected by the addition to or extension of these cables.

The test conditions, test configurations and modes of operation of the EUT shall be recorded in the test report.

4.2 Arrangements for test signals and EUT stimulating signals

For integral antenna radio communications equipment a 50Ω RF connection point shall be provided for connection to the measuring equipment.

4.2.1 Arrangements for test signals at the input to the transmitter

The transmitter shall be modulated with normal test modulation by an internal or external signal source capable of producing the appropriate drive signal (see subclause 4.5.2).

4.2.2 Arrangements for test signals at the output of the transmitter

The wanted transmitter output signal shall be delivered from the antenna connector by an appropriate screened cable. The measuring equipment for the wanted signal shall be located outside of the test environment.

Adequate measures shall be taken to avoid any effect of the interfering signal on the measuring equipment.

4.2.3 Arrangements for test signals at the input to the receiver

Unless specified otherwise in the present document, the wanted input signal to establish a communication link shall be at a level 40 dB above that which just supports normal link performance (or less, as declared by the manufacturer). This level of the wanted input signal is expected to represent a normal operational signal level and should be sufficient to prevent broad band noise from the operation of the power amplifiers used for the immunity test, from influencing the test. The source of the wanted input signal shall be located outside of the test environment.

The wanted input signal shall be presented to the antenna connector by a coaxial cable.

Test signal sources which are applied to the receiver shall present a correct impedance to the receiver input. This requirement shall be met irrespective of whether one or more signals are applied to the receiver simultaneously.

4.2.4 Arrangements for test signals at the output from the receiver

For speech equipment, where the receiver does not have a connector providing the receiver output, the audio frequency output of the receiver should be coupled via an electrically non-conductive acoustic tube to an audio distortion meter or other measuring equipment located outside of the test environment.

Where the receiver has a connector providing the receiver output this should be used to connect the output to an audio distortion meter or other suitable measuring equipment located outside of the test environment. A description of the test arrangement shall be recorded in the test report. Precautions shall be taken to ensure that any effect on the test is minimized.

For datalink equipment, the output of the receiver should be connected to test equipment located outside of the test environment. This test equipment may be supplied by the manufacturer.

Precautions shall be taken to ensure that any effect on the test is minimized.

A description of the test system shall be recorded in the test report.

4.2.5 Cabinet radiation

This test is applicable to receivers, transmitters and transceivers and ancillary equipment, and shall be performed in accordance with subclause 8.5.

4.2.6 Arrangements for the application of immunity test signals

These are detailed in the relevant standards referred to in the present document.

4.3 Exclusion bands

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

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

The RF test exclusions are referred to as "exclusion bands" and are elaborated below for the various cases.

4.3.1 Transmitter exclusion bands for EM emission measurements

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

The exclusion band for transmitters is given in table 1.

Table 1: Transmitter exclusion bands for emission measurements

Category of EUT	Width of exclusion band (notes 1 and 2)	Centre of exclusion band
8,33 kHz equipment	2,042 MHz or 2,442 MHz	F _c
25 kHz equipment	2,125 MHz or 2,525 MHz	F _c
NOTE 1: The exclusion band is the product of 5 times the receiver bandwidth plus 20 times the measurement bandwidth (100 kHz or 120 kHz) for the measurement range 30 MHz to 1 GHz.		
NOTE 2: The extension of the exclusion bandwidth for transmitters to include 20 times the measurement bandwidth is needed to accommodate the skirt bandwidth of the filters used in the measurement equipment. Narrower measurement bandwidths may be used. The exclusion band and measurement bandwidth shall be recorded in the test report.		

4.3.2 Transmitter exclusion bands for immunity testing

The exclusion band extends plus and minus twice the occupied bandwidth (BW) from the centre frequency ($F_c \pm 2 BW$).

The exclusion band extends plus and minus twice the occupied bandwidth (BW) from the centre frequency ($F_c \pm 2 BW$).

For 25 kHz equipment the exclusion band extends ± 50 kHz, and for 8,33 kHz equipment $\pm 16,7$ kHz around the centre frequency

4.3.3 Receiver exclusion bands for immunity testing

The exclusion band is the operating frequency range, extended at each end by $\pm 5\%$ of the centre frequency

For the centre frequency 127,5 MHz, the exclusion band extends from 111,625 MHz (118 MHz minus 6,375 MHz) to 143,35 MHz (136,975 MHz plus 6,375 MHz)

4.4 Test conditions for EM emission measurements

The measurement shall be made in the operational mode producing the largest emissions 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.

Measurements shall be performed on a transmitter when transmitting at the highest rated power and whilst in standby.

A single tone or a bit stream shall be used to modulate the transmitter as defined in subclause 4.5.2.

For receivers, the wanted input signal coupled to the receiver shall be modulated with normal test modulation (subclause 4.5.2). Where possible, a continuous communication link shall be established (subclause 5.2) at the start of the test.

4.5 Test conditions for EM immunity tests

The measurement shall be made in the mode of operation as required in subclause 4.5.1.

For the immunity tests of ancillary equipment without 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.

4.5.1 Mode of operation

The transmitter shall be operated at its maximum rated RF output (PEP), or at a level not less than -6 dB relative to that power level in the event of declared thermal limitations.

The transmitter shall be modulated with normal test modulation (subclause 4.5.2). Where possible, a continuous communication link shall be established (subclause 5.2) at the start of the test, and the performance criteria in subclause 6.2.1 shall apply. Where the equipment does not support a continuous communications link, the performance criteria in subclause 6.2.2 shall apply.

For the immunity tests of receivers, the wanted input signal coupled to the receiver shall be modulated with normal test modulation (subclause 4.5.2). Where possible, a continuous communication link shall be established (subclause 5.2) at the start of the test, and the performance criteria in subclause 6.2.1 shall apply. Where the equipment does not support a continuous communications link, the performance criteria in subclause 6.2.2 shall apply.

4.5.2 Normal test modulation

For analogue speech equipment:

- the receiver input signal shall be set to the nominal operating frequency, modulated with a sinusoidal audio frequency of 1 kHz at 30 % depth and at a level which gives a SINAD of 20 dB at the receiver output;
- transmitters shall be modulated with a sinusoidal audio frequency signal of 1 kHz. The level of this audio signal shall be set to obtain at least 80 % modulation depth of the RF output signal.

For VDL Mode 2 equipment:

- the receiver input signal shall be set to the nominal frequency of the receiver, modulated with a test signal specified by the manufacturer which represents normal operation;
- the transmitter shall be modulated with a test signal which represents normal operation as specified by the manufacturer;
- the manufacturer may supply the test modulation/demodulation equipment;
- the test signal generator (modulation) shall be able to produce a continuous stream of data or a repetitive message as appropriate;
- in the case of data equipment, the test instrumentation shall be able to produce;
- a readout of BER of a continuous data stream; or
- a repetitive readout of message acceptance or an indication of data throughput rate in the case of error-corrected systems.

5 Performance assessment

5.1 General

The manufacturer shall supply the following information concerning the EUT, to be recorded in the test report:

- the primary user functions of the EUT to be tested during and after the EMC testing;
- the intended functions of the EUT which shall be in accordance with its user documentation;
- the type of modulation and characteristics of the transmission used for testing (random bit stream, message format, etc.);
- the ancillary equipment to be combined with the radio equipment for testing, if any;
- the method to be used to verify that a communications link is established and maintained;
- 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 affected after EM stress;
- an exhaustive list of ports, classified as power, telecom, antenna or signal/control, and the maximum lengths of cables that may be connected. Power ports shall further be classified as a.c. or d.c. power;
- a list of service connectors or programming connectors;
- the bandwidth of the I.F filter(s) (immediately preceding the demodulator) in the receiver;
- details of the operating frequency range of the EUT;
- details of the mechanism for manual recovery of normal operation shall be provided in the user documentation;
- the EUT software version used during the test.

5.2 EUTs which can provide a continuous communications link

If the EUT permits the establishment of a continuous communications link, the test modulation, test arrangement etc. as required in clause 4 shall apply.

5.3 EUTs which can only provide a discontinuous/duty cycle communications link

If the EUT does not permit a continuous communications link to be established, or in the case of ancillary equipment tested on a stand alone basis, the manufacturer shall define the method of test to determine the acceptable level of performance or degradation of performance during and/or after the test. The manufacturer shall provide the following:

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

The assessment of performance to be carried out during and/or after the tests shall be simple, but at the same time give adequate proof that the primary functions of the EUT are operational.

5.4 EUT classification

Portable equipment, or combinations of equipment, declared as capable of being powered, for intended use, by the **main battery of a vehicle** shall additionally be considered as equipment intended for vehicular use.

Portable or mobile equipment or combinations of equipment declared as capable of being powered for intended use by **a.c. mains** shall additionally be considered as equipment intended for fixed use.

5.4 Ancillary equipment - methods of assessing compliance

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

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

6 Performance criteria

The EUT shall meet the minimum performance criteria specified in subclauses 6.1 and 6.2 as appropriate.

6.1 General

The EUT shall meet the performance criteria given in table 2 including the associated notes 1 and 2.

Where the EUT is a transmitter only, tests shall be repeated with the EUT in standby. The transmitter shall not operate unintentionally during the test.

Where the EUT is a transceiver, the transmitter shall not operate unintentionally during the test, under any circumstances.

The performance criteria A, B and C as indicated in table 2 shall be used in the following manner:

- performance criteria **A** for immunity tests with phenomena of a **continuous** nature;
- performance criteria **B** for immunity tests with phenomena of a **transient** nature or where called for in specific subclauses of the present document;
- performance criteria **C** for immunity tests with power interruptions exceeding a certain period of time (see subclause 9.4).

Table 2: Performance criteria

Criteria	During test	After test
A	Operate as intended Degradation of performance (note 1) No loss of function	Operate as intended No degradation of performance (note 2) No loss of function
B	Loss of function (one or more)	Operate as intended No degradation of performance (note 2) Functions self-recoverable
C	Loss of function (one or more)	Operate as intended No degradation of performance (note 2) Functions recoverable by the operator (note 3)
<p>NOTE 1: Degradation of performance during the test is understood as a degradation to a level not below a minimum performance level specified by the manufacturer for the use of the apparatus as intended. In some cases the specified minimum performance level may be replaced by a permissible degradation of performance.</p> <p>NOTE 2: No degradation of performance after the test is understood as no degradation below a minimum performance level specified by the manufacturer for the use of the apparatus as intended. In some cases the specified minimum performance level may be replaced by a permissible degradation of performance. The test shall not cause a change of actual operating data or user retrievable data.</p> <p>NOTE 3: The EUT combined with its test support equipment should provide an indication of the need for manual operation to recover normal functionality of the product following EM stress. Where this is provided, full details of the necessary recovery action and diagnostics provided by the EUT shall be recorded in the test report</p>		

6.2 Assessment of immunity

6.2.1 EUTs capable of establishing a continuous communications link

The establishment of the communications link at the start of the test, the maintenance of the communications link and the assessment of the recovered signal information, e.g. an audio signal, shall be used as the performance criteria to ensure that the essential functions of the EUT are evaluated during and after the test.

6.2.2 EUTs only capable of establishing a discontinuous communications link

If the EUT does not permit a continuous communications link to be established, or in the case of ancillary equipment being tested on a stand alone basis, the manufacturer shall declare, for inclusion in the test report, the acceptable level of performance or degradation of performance during and/or after testing. The performance specification shall be included in the product description and documentation.

The performance criteria specified by the manufacturer shall provide at least the same degree of immunity protection as specified in subclause 6.1.

6.2.3 Assessment of receiver responses

Unwanted signal responses on receivers and receivers of transceivers.

If during an RF test an unwanted signal creates a degradation such that the SINAD is reduced to 14dB or causes the data output to be corrupted, the phenomenon is considered an EMC problem and the equipment fails the test.

6.2.4 Assessment of transmitter response

AM transmitters shall be considered to fail an RF immunity test if the received modulation SINAD ratio reduces by 6 dB.

7 Applicability overview tables

7.1 Emission measurements

Table 3: Emission measurements applicability

Application	Equipment test requirement			Reference subclause in the present document	Reference document
	Radio and ancillary equipment for fixed use	Radio and ancillary equipment for vehicular use	Radio and ancillary equipment for portable and handheld use		
Enclosure port (note)	applicable for receivers, transmitters, transceivers and ancillary equipment	applicable for receivers, transmitters, transceivers and ancillary equipment	applicable for receivers, transmitters, transceivers and ancillary equipment	8.1	EN 55022 [4]
DC power in/out ports	applicable	applicable	if provided	8.2	EN 55022 [4] CISPR 16-1 [5]
AC mains ports	applicable	not applicable	if provided	8.3	EN 55022 [4]
Harmonic current emissions	applicable	not applicable	if >75W consumption	8.4	EN 61000-3-2 [15]
Voltage fluctuations and flicker	applicable	not applicable	not applicable	8.5	EN 61000-3-3 [16]
NOTE: These parameters are normally covered in standards relating to the use of the radio spectrum.					

7.2 EM Immunity tests

Table 4: Immunity tests applicability

Phenomena	Application	Equipment Test Requirement			Reference, subclauses in the present document	Reference document
		Radio and ancillary equipment for fixed use	Radio and ancillary equipment for vehicular use	Radio and ancillary equipment for portable and handheld use		
RF EM field (80 MHz to 1 GHz)	Enclosure port	applicable	applicable	applicable	9.1	EN 61000-4-3 [7]
Electrostatic discharge	Enclosure port	applicable	applicable	applicable	9.2	EN 61000-4-2 [6]
Fast transients common mode	Signal/control ports, DC and AC power input ports, antenna ports, telecom ports	applicable	not applicable	applicable	9.3	EN 61000-4-4 [8]
RF common mode 0,15 MHz to 80 MHz	Signal and control ports, DC and AC power input ports, antenna ports (cable), telecom ports	applicable	not applicable	applicable	9.4	EN 61000-4-6 [10]
Transient and surges, vehicular environment	DC power input ports	not applicable	applicable	applicable	9.5	ISO 7637-1 [2], ISO 7637-2 [3]
Voltage dips and interruptions	AC mains power input ports	applicable	not applicable	applicable	9.6	EN 61000-4-11 [11]
Surges, differential mode and common mode	AC mains input/output ports, telecom ports	applicable	not applicable	not applicable	9.7	EN 61000-4-5 [9]

8 Methods of measurement and limits for EM emissions

The individual measurements called up in the tables in this clause shall be performed in accordance with the standards specified in each case, using the test limits indicated. Any deviations from this principle are elaborated in the text.

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 for normal/typical operation, where practical.

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

If the equipment is part of a system, or can be connected to ancillary equipment, then it shall be acceptable to test the equipment while connected to the minimum representative configuration of ancillary equipment necessary to exercise the ports.

If the equipment has a large number of ports, then a sufficient number shall be selected to simulate actual operational conditions and to ensure that all the different types of termination are covered.

Ports which in normal operation are connected shall be connected to an ancillary equipment or to a representative piece of cable terminated to simulate the impedance of the ancillary equipment. RF input/output ports shall be correctly terminated.

The configuration and mode of operation during the measurements shall be precisely noted in the test report.

8.1 RF Emissions from the enclosure port

This test is applicable to receivers, transmitters, transceivers and ancillary equipment not incorporated in the radio equipment, and intended to be measured on a stand alone basis, as declared by the manufacturer. 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 their internal noise from being radiated from the enclosure.

8.1.2 Test method

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

8.1.3 Limits

The equipment shall meet the limits according to EN 55022 [4] (10 m measuring distance) shown in table 5. For transmitters measured in transmit mode of operation, the transmitter exclusion band applies, see subclause 4.3.1

Table 5: Limits

Frequency range	Limit (Quasi-peak)
30 MHz to 230MHz	30 dB μ V/m
> 230 MHz to 1GHz	37 dB μ V/m

8.2 Emissions from the DC power input/output port

This test is applicable for base station and ancillary equipment for fixed use that may have DC cables longer than 3 m.

If the DC power cable of the radio and/or the ancillary equipment is less than 3 m in length, and intended for direct connection to a dedicated AC/DC power supply, then the measurement shall be performed on the AC power input port of that power supply as specified in subclause 8.4. If the DC power cable may be longer than 3 m, then the measurement shall additionally be performed on the DC power port of the radio and/or ancillary equipment.

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 ancillary equipment and/or radio communications equipment to limit its internal noise from being present on the DC power ports.

8.2.2 Test Method

The test method shall be in accordance with EN 55022 [4] and the Line Impedance Stabilizing Networks (LISNs) shall be connected to a DC power source.

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

The equipment shall be installed with a ground plane as defined in EN 55022 [4]. The reference earth point of the LISNs shall be connected to the reference ground plane with a conductor as short as possible.

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

The measurement receiver shall be in accordance with the requirements of section 1 of CISPR 16-1 [5].

8.2.3 Limits

The equipment shall meet the limits below including the average limit and the quasi-peak limit when using, respectively, an average detector receiver and a quasi-peak detector receiver and measured in accordance with the method described in subclause 8.4.2. If the average limit is met when using a quasi-peak detector, the equipment shall be deemed to meet both limits and measurement with the average detector is unnecessary.

The equipment shall meet the limits according to EN 55022 [4], shown in table 6.

Table 6: Limits

Frequency range	Quasi-peak	Average
0,15 MHz to 0,5 MHz	66 dB μ V to 56 dB μ V	56 dB μ V to 46 dB μ V
> 0,5 MHz to 5 MHz	56 dB μ V	46 dB μ V
> 5 MHz to 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 RF Emissions from the AC mains power input/output port

8.3.1 Definition

This test assesses the ability of ancillary equipment and/or radio communications equipment to limit its internal noise from being present on the AC mains power ports.

8.3.2 Test Method

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

In the case of a AC output port, the port shall be connected via a LISN to a load drawing the rated current of the source. In case where the AC output port is directly connected (or via a circuit breaker) to the AC power port of the EUT the AC power output port need not to be tested.

NOTE: In EN 55022 [4] the term Artificial Mains Network (AMN) is used instead of LISN.

8.3.3 Limits

The equipment shall meet the limits below including the average limit and the quasi-peak limit when using, respectively, an average detector receiver and a quasi-peak detector receiver and measured in accordance with the method described in subclause 8.1.2. If the average limit is met when using a quasi-peak detector, the equipment shall be deemed to meet both limits and measurement with the average detector is unnecessary.

The equipment shall meet the limits shown in table 7

Table 7: Limits

Frequency range	Quasi-peak	Average
0,15 MHz to 0,5 MHz	66 dB μ V to 56 dB μ V	56 dB μ V to 46 dB μ V
> 0,5 MHz to 5 MHz	56 dB μ V	46 dB μ V
> 5 MHz to 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.		

8.4 Harmonic current emissions (AC mains input port)

The requirements of EN 61000-3-2 [15] for harmonic current emission apply for equipment covered by the scope of the present document, as appropriate.

8.5 Voltage fluctuations and flicker (AC mains input port)

The requirements of EN 61000-3-3 [16] for voltage fluctuations and flicker apply for equipment covered by the scope of the present document, as appropriate.

9 Test methods and levels for immunity testing

The individual tests specified in the tables of this clause, shall be performed in accordance with the standard specified in each case, using the test levels indicated. Any deviations from this principle are elaborated in the text.

The tests shall be performed in receive, standby and transmit modes of operation as supported by the EUT, unless indicated otherwise.

Decisions on the applicability of individual tests shall be based on information contained in user documentation and/or installation instructions, and consideration of the technical design of the EUT.

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

This test is applicable for radio equipment and associated ancillary equipment.

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.

9.1.1 Definition

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

9.1.2 Test method

The test method shall be in accordance with EN 61000-4-3 [7].

The following requirements and evaluation of test results shall apply:

- the test level shall be 10 V/m (measured unmodulated). The test signal shall be amplitude modulated to a depth of 80 % by a sinusoidal audio signal of 1kHz. If the wanted signal is modulated at 1 kHz, then the test signal of 400 Hz shall be used;
- the test shall be performed over the frequency range 80 MHz to 1 GHz with the exception of the exclusion band for transmitters or with the exception of the exclusion band for receivers (see clause 4), as appropriate;
- for receivers and transmitters, the stepped frequency increments of the interfering signal shall be as stated in the relevant part dealing with each radio equipment;

- any spot frequency test is defined in the relevant part dealing with each radio equipment;
- the frequencies selected and used during the test shall be recorded in the test report.

9.1.3 Performance criteria

For transmitters the performance criteria for continuous phenomena shall apply (see clause 6).

For receivers the performance criteria for continuous phenomena shall apply (see clause 6).

For ancillary equipment the pass/failure criteria supplied by the manufacturer (see clause 5) shall apply, unless the ancillary equipment is tested in connection with a receiver or transmitter in which case the corresponding performance criteria above shall apply.

9.2 Electrostatic discharge

This test is applicable for radio equipment and associated ancillary equipment.

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.

9.2.1 Definition

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

9.2.2 Test method

The test method shall be in accordance with EN 61000-4-2 [6].

For radio equipment and ancillary equipment the following requirements and evaluation of test results shall apply.

The test severity level for contact discharge shall be 4 kV and for air discharge 8 kV. All other details, including intermediate test levels, are contained within EN 61000-4-2 [6].

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 (EN 61000-4-2 [6]).

9.2.3 Performance criteria

For transmitters the performance criteria for transient phenomena shall apply (see clause 6).

For receivers the performance criteria for Transient phenomena for Receivers shall apply (see clause 6).

For ancillary equipment the pass/failure criteria supplied by the manufacturer (see clause 5) shall apply, unless the ancillary equipment is tested in connection with a receiver or transmitter in which case the corresponding performance criteria above shall apply.

9.3 Fast transients common mode

This test shall be performed on the AC mains power port (if any) of radio equipment and associated ancillary equipment.

This test shall be additionally performed on signal ports, control ports, and DC power ports, of radio equipment and associated ancillary equipment, if the cables may be longer than 3 m.

Where this test is not carried out on any port because the manufacturer declares that it is not intended to be used with cables longer than 3 m, a list of ports which were not tested for this reason shall be included in the test report.

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

9.3.1 Definition

This test assesses the ability of radio equipment 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

The requirements in table 9 and evaluation of test results shall apply:

Table 9

Phenomena	Test Levels signal and control ports	Test Levels DC power i/p ports	Test Levels AC power i/p ports	Basic Standard	Performance Criteria
Fast transients common mode	1,0 kV 5/50 ns 5 kHz	2,0 kV 5/50 ns 5 kHz	2,0 kV 5/50 ns 5 kHz	EN 61000-4-4 [8]	B

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

9.3.3 Ancillary equipment

For ancillary equipment the pass/failure criteria supplied by the manufacturer (see clause 5) shall apply, unless the ancillary equipment is tested in connection with a receiver or transmitter in which case the corresponding performance criteria shall apply.

9.4 Radio frequency common mode

This test shall be performed on the AC mains power port (if any) of radio equipment and associated ancillary equipment.

This test shall be additionally performed on signal ports, control ports, and DC power ports, of radio equipment and associated ancillary equipment, if the cables may be longer than 3 m.

Where this test is not carried out on any port because the manufacturer declares that it is not intended to be used with cables longer than 3 m, a list of ports which were not tested for this reason shall be included in the test report.

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

9.4.1 Definition

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

9.4.2 Test method

The test method shall be in accordance with EN 61000-4-6 [10].

The following requirements and evaluation of test results shall apply:

- the test level shall be severity level 3 as given in EN 61000-4-6 [10] corresponding to 10 V RMS unmodulated. The test signal shall then be amplitude modulated to a depth of 80 % by a sinusoidal audio signal of 1 kHz. If the wanted signal is modulated at 1 kHz, then the test signal of 400 Hz shall be used;

- the test shall be performed over the frequency range 150 kHz to 80 MHz. with the exception of an exclusion band for transmitters, and for receivers and duplex transceivers, (see clause 4);
- for receivers and transmitters only the stepped frequency increments shall be 50 kHz in the frequency range 150 kHz to 5 MHz and 1 % frequency increment of the momentary frequency in the frequency range 5 MHz to 80 MHz;
- for transmitters in transceivers with a non-continuous duty cycle the stepped frequency increments may be 500 kHz in the frequency range 150 kHz to 5 MHz and 10 % frequency increment of the momentary frequency in the frequency range 5 MHz to 80 MHz;
- 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.

9.4.3 Performance criteria

For transmitters the performance criteria for continuous phenomena shall apply (see clause 6).

For receivers the performance criteria for continuous phenomena shall apply (see clause 6).

For ancillary equipment the pass/failure criteria supplied by the manufacturer (see clause 5) shall apply, unless the ancillary equipment is tested in connection with receivers or transmitters in which case the corresponding performance criteria above shall apply.

9.5 Transients and surges in the vehicular environment

These tests are applicable to mobile and ancillary equipment intended for use in a vehicular environment.

These tests shall be performed on 12 V and 24 V DC power input ports of mobile and ancillary equipment, intended for mobile use in vehicles.

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.

9.5.1 Definition

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

9.5.2 Test method

The test method shall be in accordance with ISO 7637-1 [2] for 12 V DC powered equipment and ISO 7637-2 [3] for 24 V DC powered equipment.

9.5.2.1 Immunity levels: 12 V DC powered equipment

Where the manufacturer in his installation documentation requires the radio equipment to have a direct connection to the 12 V main vehicle battery the requirements of table 10 in a) shall apply.

Where the manufacturer does not require the radio equipment to have a direct connection to the 12V main vehicle battery the requirements of table 10 in a) and b) shall apply:

- a) Pulses 3a, 3b and 4;
- b) Pulses 1, 2, and 7.

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

Table 10: 12 V equipment test levels

ISO 7637-1 [2] Pulse	Level	Pulse qty	Characteristics	Test time
1	II	10		2.5 seconds
2	II	10		2.5 seconds
3a	II			5 minutes
3b	II			5 minutes
4	II	5	$V_s = -5\text{ V}$ $V_a = -2,5\text{ V}$ $t_6 = 25\text{ ms}$ $t_8 = 5\text{ s}$ $t_f = 5\text{ ms}$	
7	II	5		

9.5.2.2 Test requirements for 24 V DC powered equipment

Where the manufacturer in his installation documentation requires the radio equipment to have a direct connection to the 24 V main vehicle battery the requirements of table 11 in a) shall apply.

Where the manufacturer does not require the radio equipment to have a direct connection to the 24 V main vehicle battery the requirements of table 11 in a) and b) shall apply:

- a) Pulses 3a, 3b and 4;
- b) Pulses 1a, 1b.

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

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

Table 11: 24 V equipment test levels

ISO 7637-2 [3] Pulse	Level	Pulse qty	Characteristics	Test time
1a	II	10	$t_1 = 2,5\text{ s}$ $R_i = 25\ \Omega$	
1b	II	10	$t_1 = 2,5\text{ s}$ $R_i = 100\ \Omega$	
3a	II			5 minutes
3b	II			5 minutes
4	II	5	$V_s = -10\text{ V}$ $V_a = -5\text{ V}$ $t_6 = 25\text{ ms}$ $t_8 = 5\text{ s}$ $t_f = 5\text{ ms}$	

9.5.3 Performance criteria

For transmitters pulse 3a and 3b the performance criteria for continuous phenomena shall apply (see clause).

For pulse 1, 1a, 1b, 2, 4 and 7 the performance criteria for transient phenomena shall apply (see clause 6), with the exception that a communication link need not to be maintained during exposure and may have to be re-established.

For receivers pulse 3a and 3b the performance criteria for continuous phenomena shall apply (see clause 6)

For pulse 1, 1a, 1b, 2, 4 and 7 the performance criteria for transient phenomena shall apply (see clause 6), with the exception that a communication link need not to be maintained during exposure and may have to be re-established.

For ancillary equipment the pass/failure criteria supplied by the manufacturer (see clause 5) shall apply, unless the ancillary equipment is tested in connection with radio equipment in which case the corresponding performance criteria above shall apply.

9.6 Voltage dips and interruptions

This test shall be performed on the AC mains power port (if any) of radio equipment and associated ancillary equipment.

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.

9.6.1 Definition

These tests assess the ability of radio equipment 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

The following requirements and evaluation of test results shall apply.

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

The test levels shall be:

- a voltage dip corresponding to a reduction of the supply voltage of 30 % for 10 ms; and
- a voltage dip corresponding to a reduction of the supply voltage of 60 % for 100 ms; and
- a voltage interruption corresponding to a reduction of the supply voltage of greater than 95 % for 5 seconds.

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 apply:

- for transmitters the performance criteria for continuous phenomena shall apply (see clause 6);
- for receivers the performance criteria for continuous phenomena shall apply (see clause 6);
- for ancillary equipment the pass/failure criteria supplied by the manufacturer (see clause 5) shall apply, unless the ancillary equipment is tested in connection with a receiver or transmitter in which case the corresponding performance criteria above shall apply.

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

- for transmitters the performance criteria for transient phenomena shall apply (see clause 6);
- for receivers the performance criteria for transient phenomena shall apply (see clause 6);
- for ancillary equipment the pass/failure criteria supplied by the manufacturer (see clause 5) shall apply, unless the ancillary equipment is tested in connection with a receiver or transmitter in which case the corresponding performance criteria above shall apply.

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

- in the case where the equipment is fitted with or connected to a battery back-up, the performance criteria for transient phenomena shall apply (see clause 6);

- in the case where the equipment is powered solely from the AC mains supply (without the use of a parallel battery back-up) volatile user data may have been lost and if applicable the communication link need not to be maintained and lost functions should be recoverable by user or operator;
- no unintentional responses shall occur at the end of the test;
- in the event of loss of function(s) or in the event of loss of user stored data, this fact shall be recorded in the test report, the product description and the user documentation.

9.7 Surges

This test shall be performed on the AC mains power port (if any) of radio equipment and associated ancillary equipment.

This test shall be additionally performed on signal ports intended to be directly connected to telecommunication network, if any.

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 radio equipment and ancillary equipment to operate as intended in the event of surges present on the AC mains power input ports.

9.7.2 Test method

The requirements in table 12 and evaluation of test results shall apply:

Table 12

Phenomena	Test Levels telecom port	Test Levels a.c pwr i/p	Basic Standard	Performance Criteria
Surges common mode (line to ground)	1 kV (note)	2,0 kV 1,2/50µs (8/20)	EN 61000-4-5 [9]	B
Surges differential mode (line to line)		1 kV 1,2/50µs (8/20)	EN 61000-4-5 [9]	B
NOTE: The total output impedance of the surge generator shall be 42 Ω.				

9.7.3 Ancillary equipment

For ancillary equipment the pass/failure criteria supplied by the manufacturer (see clause 5) shall apply, unless the ancillary equipment is tested in connection with a receiver or transmitter in which case the corresponding performance criteria above shall apply.

10 Measurement uncertainty

For parameters addressed in ETR 028 [14], the test report shall contain a declaration of the actual measurement uncertainty associated with the measurements.

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

Table A.1: Clause/ subclause of the present document relevant for compliance
with the essential requirements of EC Council Directives

Clause/ subclause Number	Title	Corresponding Article of Council Directive 89/336/EEC [1]
8	Methods of measurement and limits for EMC emissions	
8.1	Emissions from the enclosure port	4(a)
8.2	Emissions from the DC power input/output port	4(a)
8.3	Emissions from the AC mains power input/output port	4(a)
8.4	Harmonic current emissions	4(a)
8.5	Voltage fluctuations and flicker	4(a)
9	Test methods and levels for immunity testing	
9.1	Radio frequency electromagnetic field (80 MHz to 1 GHz)	4(b)
9.2	Electrostatic discharge	4(b)
9.3	Fast transients common mode	4(b)
9.4	Radio frequency common mode	4(b)
9.5	Transients and surges in the vehicular environment	4(b)
9.6	Voltage dips and interruptions	4(b)
9.7	Surges	4(b)

History

Document history		
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