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*Candidate Harmonized European Standard (Telecommunications series)*

**Electromagnetic compatibility  
and Radio spectrum Matters (ERM);  
ElectroMagnetic Compatibility (EMC)  
standard for radio equipment and services;  
Part 22: Specific conditions for ground based VHF  
aeronautical mobile and fixed radio equipment**

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Reference

REN/ERM-EMC-236-22

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# Contents

Intellectual Property Rights .....	4
Foreword.....	4
1 Scope .....	5
2 References .....	5
3 Definitions and abbreviations.....	6
3.1 Definitions .....	6
3.2 Abbreviations .....	6
4 Test conditions .....	7
4.1 General .....	7
4.2 Arrangements for test signals .....	7
4.2.1 Arrangement for test signals at the input to the transmitter .....	7
4.2.2 Arrangements for test signals at the output from the transmitter .....	7
4.2.3 Arrangements for test signals at the input to the receiver .....	7
4.2.4 Arrangements for test signals at the output from the receiver .....	7
4.2.5 Arrangements for testing transmitters and receivers together (as a system) .....	7
4.3 RF exclusion band for radio communications equipment .....	8
4.3.1 Transmitter exclusion bands for EM emission measurements .....	8
4.3.2 Receiver exclusion bands for EM emission measurements .....	8
4.3.3 Transmitter exclusion bands for immunity tests .....	8
4.3.4 Receiver exclusion bands for immunity tests .....	8
4.4 Narrow band responses of receivers .....	8
4.5 Normal test modulation .....	9
5 Performance assessment.....	9
5.1 General .....	9
5.2 Equipment which can provide a continuous communications link .....	9
5.3 Equipment which does not provide a continuous or duty cycle communications link .....	10
5.4 Ancillary equipment.....	10
5.5 Equipment classification .....	10
6 Performance criteria .....	10
6.1 Performance criteria A for continuous phenomena applied to transmitters and receivers.....	11
6.2 Performance criteria B for transient phenomena applied to transmitters and receivers .....	11
6.3 Performance criteria C for immunity tests with power interruptions .....	11
6.4 Performance criteria for equipment which does not provide a continuous or duty cycle communications link.....	12
6.5 Performance criteria for ancillary equipment tested on a stand alone basis .....	12
7 Applicability overview .....	12
7.1 Emission .....	12
7.1.1 General.....	12
7.1.2 Special conditions .....	12
7.2 Immunity .....	12
7.2.1 General.....	12
7.2.2 Special conditions .....	13
<b>Annex A (normative): Definitions of ground based aeronautical radio communications equipment in the scope of the present document .....</b>	<b>14</b>
A.1 Ground based aeronautical VHF radio communications equipment.....	14
A.2 Ground based aeronautical VDL Mode 2 and VDL Mode 4 radio communications equipment .....	14
History .....	15

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Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

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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 ETSI standards One-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 [7] (as amended) laying down a procedure for the provision of information in the field of technical standards and regulations.

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 Council Directive on the approximation of the laws of the Member States relating to electromagnetic compatibility ("the EMC Directive") (89/336/EEC [3] as amended) and Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity ("the R&TTE Directive" [2]).

The present document is part 22 of a multi-part deliverable. Full details of the entire series can be found in part 1 [1].

<b>Proposed national transposition dates</b>	
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

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# 1 Scope

The present document, together with EN 301 489-1 [1] covers the assessment of ground base station, ground mobile and hand-held/portable aeronautical VHF radio communications and associated ancillary equipment, in respect of ElectroMagnetic Compatibility (EMC).

Technical specifications related to the antenna port and emissions from the enclosure port of the radio equipment covered in this scope, are not included in the present document. Such technical specifications are found in the relevant product standards for the effective use of the radio spectrum.

The present document also covers EMC requirements for VDL Mode 2 and VDL Mode 4 ground base station radio equipment.

The present document specifies the applicable test conditions, performance assessment and performance criteria for ground based aeronautical radio equipment and associated ancillary equipment.

Definitions of types of ground base station, ground mobile and hand held/portable aeronautical VHF radio communications covered by the present document are given in annex A.

In case of differences (for instance concerning special conditions, definitions, abbreviations) between the present document and EN 301 489-1 [1], the provisions of the present document take precedence.

The environmental classification and the emission and immunity requirements used in the present document are as stated in EN 301 489-1 [1], except for any specific conditions included in the present document. The applicable environments referred to in EN 301 489-1 [1] where equipment covered by the scope of the present document may be used, shall be declared by the manufacturer.

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.

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# 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 and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

Referenced documents which are not found to be publicly available in the expected location might be found at <http://docbox.etsi.org/Reference>.

- [1] ETSI EN 301 489-1: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements".
- [2] Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity (R&TTE Directive).
- [3] Council Directive 89/336/EEC of 3 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive).
- [4] ETSI EN 300 676 (V1.3.1): "ElectroMagnetic Compatibility and Radio Spectrum Matters (ERM); Ground-based VHF hand-held, mobile and fixed radio transmitters, receivers and transceivers for the VHF aeronautical mobile service using amplitude modulation; Technical characteristics and methods of measurement".

- [5] ITU Radio Regulations (1998).
- [6] ITU-T Recommendation P.53: "Psophometer for use on telephone-type circuits".
- [7] Directive 98/34/EC of the European Parliament and of the Council of 22 June 1998 laying down a procedure for the provision of information in the field of technical standards and regulations.

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## 3 Definitions and abbreviations

### 3.1 Definitions

For the purposes of the present document, the terms and definitions given in EN 301 489-1 [1], clause 3 and the following apply:

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

**centre frequency (Fc):** centre of the transmitter necessary bandwidth

**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

NOTE: An integral antenna may be internal or external to the equipment. In equipment of this type, a 50  $\Omega$  RF connection point shall be provided for test purposes.

**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 Radio Regulations, 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  $\beta/2$  of the total mean power of a given emission

NOTE: Unless otherwise specified by ITU-R for the appropriate class of emission, the value of  $\beta/2$  should be taken as 0,5 % (ITU Radio Regulations [5]).

**simplex:** instantaneous one-way communications link

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

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

### 3.2 Abbreviations

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

AC	Alternating Current
AM	Amplitude Modulation
BER	Bit Error Ratio
BW	BandWidth
D8PSK	Differentially encoded 8 Phase Shift Keying
DC	Direct Current
DSB	Double Side Band full carrier
EM	ElectroMagnetic
EMC	ElectroMagnetic Compatibility
EUT	Equipment Under Test
Fc	centre frequency
GFSK	Gaussian Frequency Shift Keying
PEP	Peak Envelope Power
RF	Radio Frequency
rms	root mean of squares

VDL            VHF Digital Link  
VHF            Very High Frequency

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## 4 Test conditions

For the purpose of the present document, the test conditions of EN 301 489-1 [1], clause 4 shall apply as appropriate. Further product related test conditions for VHF aeronautical radio equipment are specified in the present document.

### 4.1 General

For emission and immunity tests the test modulation, test arrangements, etc., as specified in the present document, clauses 4.2 to 4.5, shall apply.

### 4.2 Arrangements for test signals

The provisions of EN 301 489-1 [1], clause 4.2 shall apply with the following modification.

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

#### 4.2.1 Arrangement for test signals at the input to the transmitter

The provisions of EN 301 489-1 [1], clause 4.2.1 shall apply with the following modification.

The transmitter shall be modulated with normal test modulation by an internal or external signal source capable of producing the appropriate drive signal (see clause 4.5).

#### 4.2.2 Arrangements for test signals at the output from the transmitter

The provisions of EN 301 489-1 [1], clause 4.2.2 shall apply with the following modifications.

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 RF output signal of the transmitter shall be coupled to the measuring equipment via a shielded transmission line such as a coaxial cable. The measuring equipment shall comprise a combination of a modulation analyser and an audio distortion meter.

For transmitters with an integral antenna, a 50  $\Omega$  RF connection point shall be provided for test purposes.

#### 4.2.3 Arrangements for test signals at the input to the receiver

The provisions of EN 301 489-1 [1], clause 4.2.3 shall apply with the following modifications.

The wanted RF input signal coupled to the receiver shall be modulated with normal test modulation (see clause 4.5).

For receivers with an integral antenna, a 50  $\Omega$  RF connection point shall be provided for test purposes.

#### 4.2.4 Arrangements for test signals at the output from the receiver

The provisions of EN 301 489-1 [1], clause 4.2.4 shall apply.

#### 4.2.5 Arrangements for testing transmitters and receivers together (as a system)

The provisions of EN 301 489-1 [1], clause 4.2.5 shall apply.

## 4.3 RF exclusion band for radio communications equipment

The provisions of EN 301 489-1 [1], clause 4.3 shall apply.

Frequencies on which radio communications equipment is intended to operate are excluded from immunity tests with radiated RF test signals.

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

### 4.3.1 Transmitter exclusion bands for EM emission measurements

Exclusion bands shall apply when measuring transmitters in transmit mode of operation.

Exclusion bands shall not apply when measuring transmitters in standby mode of operation.

The exclusion band for transmitters is given in table 1.

**Table 1: Transmitter exclusion bands for emission measurements**

Category of EUT (Channel spacing)	Width of exclusion band (see notes 1 and 2)	Centre of exclusion band
8,33 kHz equipment	2,042 MHz or 2,442 MHz	F <sub>c</sub>
25 kHz equipment	2,125 MHz or 2,525 MHz	F <sub>c</sub>
NOTE 1: The exclusion band is the product of 5 times the receiver bandwidth plus 20 times the measurement bandwidth (i.e. 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. A narrower measurement bandwidth may be used. The exclusion band and measurement bandwidth shall be recorded in the test report.		

### 4.3.2 Receiver exclusion bands for EM emission measurements

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

### 4.3.3 Transmitter exclusion bands for immunity tests

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

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

### 4.3.4 Receiver exclusion bands for immunity tests

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

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

## 4.4 Narrow band responses of receivers

Any receiver response to an RF immunity test that has a bandwidth as defined in EN 301 489-1 [1], clause 4.4. shall be considered a narrow band response, and shall be subject to spurious response rejection tests specified in the relevant product standards for the effective use of the radio spectrum.



## 4.5 Normal test modulation

The normal test modulation is specified as follows:

- 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 ratio of 20 dB, measured at the receiver output using a psophometric telephone filtering network as described in ITU-T Recommendation P.53 [6];
  - the transmitter 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 and VDL Mode 4 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.

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## 5 Performance assessment

### 5.1 General

The provisions of EN 301 489-1 [1], clause 5.1 shall apply with the following modifications.

In addition, the manufacturer shall supply the following information:

- a list of service connectors or programming connectors;
- 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 Equipment which can provide a continuous communications link

The provisions of EN 301 489-1 [1], clause 5.2 shall apply with the following modification.

For immunity tests of transmitters, the transmitter shall be modulated with normal test modulation (see clause 4.5). A continuous communication link shall be established at the start of the test, and the performance criteria specified in clauses 6 to 6.5 shall apply.

For immunity tests of receivers, the wanted RF input signal coupled to the receiver shall be modulated with normal test modulation (see clause 4.5). A continuous communication link shall be established at the start of the test, and the performance criteria specified in clause 6 and its clauses shall apply.

### 5.3 Equipment which does not provide a continuous or duty cycle communications link

For radio equipment which does not support a continuous or duty cycle communications link the provisions of EN 301 489-1 [1], clauses 5.3 and 6.3 shall apply.

### 5.4 Ancillary equipment

The provisions of EN 301 489-1 [1], clause 5.4 shall apply.

### 5.5 Equipment classification

The provisions of EN 301 489-1 [1], clause 5.5 shall apply.

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## 6 Performance criteria

The EUT shall meet the performance criteria given in table 2 including the associated notes 1, 2, and 3, as detailed in clauses 6.1, 6.2, 6.3, or 6.4 as appropriate.

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 clauses of the present document;
- performance criteria C for immunity tests with power interruptions.

**Table 2: Performance criteria**

Criteria	During test	After test
A	Operate as intended Degradation of performance (see note 1) No loss of function	Operate as intended No degradation of performance (see note 2) No loss of function
B	Loss of function (one or more)	Operate as intended No degradation of performance (see note 2) Functions self-recoverable
C	Loss of function (one or more)	Operate as intended No degradation of performance (see note 2) Functions recoverable by the operator (see 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>		

## 6.1 Performance criteria A for continuous phenomena applied to transmitters and receivers

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

The performance criteria A specified in table 2 shall apply.

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

If during an RF immunity test an unwanted signal creates a degradation of the transmitter's output such that the received audio signal distortion exceeds 10 %, or causes the transmitted data to be corrupted, then the phenomenon is considered an EMC problem and the equipment fails the test.

Where the EUT is a transmitter only, tests shall be repeated with the EUT in standby mode of operation. 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.

## 6.2 Performance criteria B for transient phenomena applied to transmitters and receivers

The performance criteria B specified in table 2 shall apply.

Where the EUT is a transmitter only, tests shall be repeated with the EUT in standby mode of operation. 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.

## 6.3 Performance criteria C for immunity tests with power interruptions

Performance criteria C shall apply to a voltage interruption corresponding to a reduction of the supply voltage of greater than 95 % for 5 s:

- during the EMC exposure:
  - the communications link may be lost and one or more functions may be lost;
  - during the test there shall be no unintended transmission.
- after the EMC exposure:
  - the communications link shall be recoverable either automatically or by operational user control as declared by the manufacturer;
  - the speech quality level shall return to a level not below that specified by the manufacturer and/or the digital throughput shall return to its nominal value;
  - there shall be no unintended transmission.

## 6.4 Performance criteria for equipment which does not provide a continuous or duty cycle communications link

The provisions of EN 301 489-1 [1], clause 6.3 shall apply.

## 6.5 Performance criteria for ancillary equipment tested on a stand alone basis

The provisions of EN 301 489-1 [1], clause 6.4 shall apply.

# 7 Applicability overview

## 7.1 Emission

### 7.1.1 General

EN 301 489-1 [1], table 2, contains the applicability of EMC emission measurements to the relevant ports of radio and/or associated ancillary equipment.

### 7.1.2 Special conditions

The following special conditions set out below relate to the methods of measurement for EM emissions used in EN 301 489-1 [1], clause 8.

**Table 3: Special conditions for EM emission measurements**

Reference to clauses in EN 301 489-1 [1]	Special product-related conditions, additional to or modifying the test conditions in EN 301 489-1 [1], clause 8
<b>8.1: Test configuration; Methods of measurement and limits for EM emissions</b>	<b>Modes of operation to be investigated:</b> <ul style="list-style-type: none"> <li>- on a transmitter, the measurements shall be performed when transmitting at the highest rated power, and whilst in standby mode of operation;</li> <li>- a single tone or a bit stream shall be used to modulate the transmitter as defined in clause 4.5 of the present document.</li> </ul>

## 7.2 Immunity

### 7.2.1 General

EN 301 489-1 [1], table 3 contains the applicability of EMC immunity measurements to the relevant ports of radio and/or associated ancillary equipment.

## 7.2.2 Special conditions

The following special conditions set out below relate to the immunity test methods and performance criteria used in EN 301 489-1 [1], clause 9.

**Table 4: Special conditions for EMC immunity tests**

Reference to clauses in EN 301 489-1 [1]	Special product-related conditions, additional to or modifying the test conditions in EN 301 489-1 [1], clause 9
<b>9.2.2: Test method; Radio frequency electromagnetic field</b>	<b>Level of the immunity RF test signal:</b> - the test level over the frequency range 80 MHz to 1 400 MHz shall be 10V/m (measured unmodulated). - the test level over the frequency range 1400 MHz-2 000 MHz, shall be 3V/m (measured unmodulated)
<b>9.4.2: Test method; Fast transients, common mode</b>	<b>Level of the immunity test signals:</b> - the test level for signal, telecommunications, and control ports shall be 1 kV open circuit voltage; - the test level for DC power input ports shall be 2 kV open circuit voltage; - the test level for AC mains power input ports shall be 2 kV open circuit voltage. <b>Test signal characteristics and application:</b> - the test signal shall have 5/50 ns and 5 kHz characteristics; - 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 $\Omega$ ; - where simultaneous AC and DC supply is possible, the DC supply shall be switched off.
<b>9.5.2: Test method; Radio frequency, common mode</b>	<b>Level of the immunity RF test signal:</b> - the test level shall be 10V rms; - where simultaneous AC and DC supply is possible, the DC supply shall be switched off; - when testing the DC power port, the AC supply shall be switched off.
<b>9.7.2 Test method; Voltage dips and interruptions</b>	<b>Test signal characteristics and application:</b> - where simultaneous AC and DC supply is possible, the DC supply shall be switched off.
<b>9.8.2: Test method; Surges</b>	<b>Level of the immunity test signals:</b> - the test level for telecommunication ports intended to be directly connected to a telecommunications network shall be 1 kV line to ground. In this case, the total output impedance of the surge generator shall be 2 $\Omega$ ; - the test level for AC mains power input ports shall be 2 kV line to ground and 1 kV line to line, and the characteristics of the surge generator shall be 1,2/50 $\mu$ s and 8/20. <b>Test signal characteristics and application:</b> - where simultaneous AC and DC supply is possible, the DC supply shall be switched off.

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## Annex A (normative): Definitions of ground based aeronautical radio communications equipment in the scope of the present document

### A.1 Ground based aeronautical VHF radio communications equipment

The present document, applies to ground base station, ground mobile and hand held/portable aeronautical VHF radio communications and associated ancillary equipment, as defined in EN 300 676 [4].

Ground based aeronautical VHF radio communications equipment in the scope of the present document are characterized by the following operating conditions:

- 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, GFSK or D8PSK modulation; and

comprises ground base station, mobile, and hand held/portable applications.

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### A.2 Ground based aeronautical VDL Mode 2 and VDL Mode 4 radio communications equipment

The present document also covers EMC requirements for VDL Mode 2 and VDL Mode 4 ground base station radio equipment.

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## History

<b>Document history</b>		
V1.1.1	December 2000	Publication
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