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**ElectroMagnetic Compatibility (EMC)
standard for radio equipment and services;
Part 54: Specific conditions for fixed ground based
aeronautical and meteorological radars;
Harmonised Standard for electromagnetic compatibility**

Reference

DEN/ERM-EMC-401

Keywords

aeronautical, EMC, harmonised standard,
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Foreword

This Harmonised European Standard (EN) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.2] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.1].

Once the present document is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of the present document given in table A.1 confers, within the limits of the scope of the present document, a presumption of conformity with the corresponding essential requirements of that Directive and associated EFTA regulations.

The present document is part 54 of a multi-part deliverable. Full details of the entire series can be found in part 1 [1].

National transposition dates	
Date of adoption of this EN:	29 September 2022
Date of latest announcement of this EN (doa):	31 December 2022
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	30 June 2023
Date of withdrawal of any conflicting National Standard (dow):	30 June 2024

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the [ETSI Drafting Rules](#) (Verbal forms for the expression of provisions).

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1 Scope

The present document specifies technical characteristics and methods of measurement in respect of ElectroMagnetic Compatibility (EMC) for the following radar systems:

- Fixed and ground based monostatic aeronautical Primary Surveillance Radar (PSR) and Surface Movement Radar (SMR)
- Fixed and ground based monostatic meteorological radar system, for example weather radar systems or wind profiler

with the following characteristics:

- operating in at least one of the frequency ranges as shown in table 1;
- operated only by AC power.

The above mentioned radio equipment is intended to be used at a fixed location (permanent or temporarily) and is equipped with rotating passive antennas.

A radar system consists of one or more enclosures that contain at least the following radar functionalities: transmitter, receiver, signal processing. Other parts which are not part of the radar functionality e.g. local UPS, air conditioning equipment, dehumidifying equipment, communication network equipment, etc., are not in the scope of the present document, unless these parts are implemented inside the radar system enclosure(s).

Table 1: Frequency range of fixed ground based aeronautical and meteorological radar systems

Operating frequency ranges
1 215 MHz to 1 400 MHz
2 700 MHz to 3 100 MHz
5 250 MHz to 5 850 MHz
8 500 MHz to 10 500 MHz

Technical specifications related to the antenna port of the radio equipment are not included in the present document. Such technical specifications are found in the relevant product standards under article 3.2 of Directive 2014/53/EU [i.1].

Emission requirements in the present document are specified for frequencies above 9 kHz.

The environmental classification and the emission and immunity requirements used in the present document are as stated in ETSI EN 301 489-1 [1], except for any special conditions included in the present document.

NOTE: The relationship between the present document and essential requirements of article 3.1(b) of Directive 2014/53/EU [i.1] is given in annex A.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are necessary for the application of the present document.

- [1] ETSI EN 301 489-1 (V2.2.3) (11-2019): "Electro Magnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements; Harmonised Standard for ElectroMagnetic Compatibility".

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

- [i.1] Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC.
- [i.2] Commission Implementing Decision C(2015) 5376 final of 4.8.2015 on a standardisation request to the European Committee for Electrotechnical Standardisation and to the European Telecommunications Standards Institute as regards radio equipment in support of Directive 2014/53/EU of the European Parliament and of the Council.
- [i.3] ITU Radio Regulations (2020).
- [i.4] EN 55032:2015: "Electromagnetic compatibility of multimedia equipment - Emission Requirements", (produced by CENELEC).
- [i.5] Recommendation ITU-R SM.1541-6 (08/2015): "Unwanted emissions in the out-of-band domain".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document the following terms apply:

ancillary equipment: electrical or electronic equipment, that is intended to be used with a receiver or transmitter

NOTE 1: It is considered as an ancillary equipment if:

- the equipment is intended for use with a receiver or transmitter to provide additional operational and/or control features to the radio equipment (e.g. to extend control to another position or location);
- the ancillary equipment cannot be used without being connected to radio equipment to provide user functions independently of a receiver or transmitter; and
- the receiver or transmitter, 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).

NOTE 2: An example of ancillary equipment would be a docking station for radio equipment whose interface is dedicated to a particular product or range of products.

antenna port: port, for connection of an antenna used for intentional transmission and/or reception of radiated RF energy

centre frequency (f_c): centre of the transmitter necessary bandwidth

critical stored data: data that is essential for an EUT to perform a primary function in accordance with that EUT's specification

NOTE: This may include data previously stored by the user.

enclosure port: physical boundary of the equipment through which electromagnetic fields may radiate or impinge

NOTE: Also known as cabinet radiation.

Equipment Under Test (EUT): equipment subject to the performance requirements of the present document

mode of operation: operational status of the radar system, for example but not limited to standby or operating mode

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; unless otherwise specified in a Recommendation ITU-R for the appropriate class of emission, the value of $\beta/2$ should be taken as 0,5 %

NOTE: This definition is taken from the ITU Radio Regulations [i.3].

operating mode: mode of operation which produces the authorized emission

port: interfaces of the equipment with the external environment and other equipment

NOTE: An example of the ports is shown in figure 1.

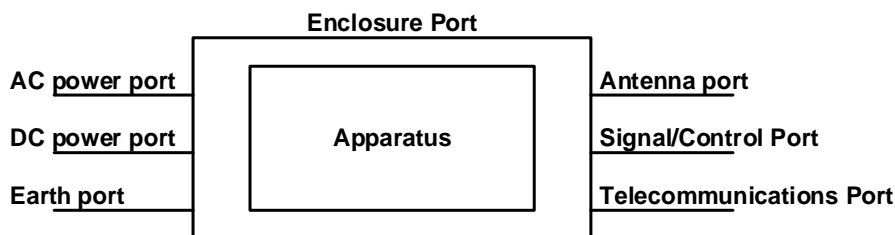


Figure 1: Example of ports

standby mode: mode of operation where the transmitter is available for operation but is not in the operating mode

3.2 Symbols

For the purposes of the present document, the symbols given in ETSI EN 301 489-1 [1] and the following apply:

$\text{Band}_{\text{RX}}(\text{lower})$	Lower edge, in terms of frequency, of the tuning range or allocated band of the receiver under assessment
$\text{Band}_{\text{RX}}(\text{upper})$	Upper edge, in terms of frequency, of the tuning range or allocated band of the receiver under assessment
B_{-40}	-40 dB bandwidth
B_C	Chirp bandwidth
$\text{EXband}(\text{lower})$	Exclusion band lower frequency edge
$\text{EXband}(\text{upper})$	Exclusion band upper frequency edge
k	Boltzmann's constant
t	Pulse duration
t_r	Pulse rise time

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI EN 301 489-1 [1] and the following apply:

AC	Alternating Current
BITE	Built In Test Equipment
dB	decibel
DC	Direct Current
EM	ElectroMagnetic
EMC	ElectroMagnetic Compatibility
EUT	Equipment Under Test
f_c	centre frequency
PPI	Plan Position Indicator
PSR	Primary Surveillance Radar
RF	Radio Frequency
SMR	Surface Movement Radar

4 Test conditions

4.1 General requirements

For the purpose of the present document, the provisions of ETSI EN 301 489-1 [1], clause 4 shall apply with the following additions from clauses 4.2.1 to 4.2.4 of the present document.

The EUT shall be tested in the operating mode and standby mode to confirm there are no unintentional responses.

If the equipment has a number of ports with identical design, then at least one of these ports shall be activated and shall be monitored during the tests. The decision and justification not to perform tests on all available ports shall be recorded in the test report.

Conducted immunity test shall not be applied to the signal ports that, according to the product documentation, are not permanently connected but just used to setup or perform a maintenance activity of the equipment; these maintenance activities are not intended as operating conditions.

The test configuration and modes of operation shall represent the intended use and shall be recorded in the test report.

4.2 Arrangements for test signals

4.2.1 Arrangements for test signals at the input of transmitters

The provisions of ETSI EN 301 489-1 [1], clause 4.2.1 apply with the following additions:

- 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 4.4).

4.2.2 Arrangements for test signals at the output of transmitters

The provisions of ETSI EN 301 489-1 [1], clause 4.2.2 apply with the following additions:

- The transmitter shall be operated at its maximum rated RF peak output power and maximum possible duty cycle.
- The RF output power of the transmitter shall be directed to a dummy load.

4.2.3 Arrangements for test signals at the input of receivers

The provisions of ETSI EN 301 489-1 [1], clause 4.2.3 apply with the following additions:

- The radar shall be kept in an operating mode which represents the intended use and all necessary signal processing shall be enabled in the same manner. All external inputs and outputs necessary for the intended use shall be connected.
- As ground based aeronautical and meteorological radars do not establish a communication link, a test signal shall be connected to the antenna input port of the receiver. The applied test signal shall generate data at the outputs of the radar system, which are similar to the data generated during the intended operation mode of the radar system. If an internal test signal is available this shall be used otherwise an external test signal shall be applied.

NOTE: Aeronautical and meteorological radar systems usually have an internal test signal generator.

4.2.4 Arrangements for test signals at the output of receivers

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

4.3 RF exclusion band for radio equipment

4.3.1 General requirements

The exclusion band for transmitters and transmitter sections of transceivers is the band of frequencies over which no immunity tests with radiated RF are made.

The transmitter and receiver exclusion bands as defined in clauses 4.3.2 and 4.3.3 shall apply. For equipment operating at frequencies above 6 000 MHz the transmitter and receiver exclusion bands are not applicable as test ranges stop at 6 000 MHz.

NOTE: ETSI EN 301 489-1 [1] requires emission and immunity tests of frequencies up to 6 000 MHz.

Whenever an exclusion band is applied, the specific frequency range(s) excluded from assessment shall be detailed in the technical documentation.

4.3.2 Exclusion band for transmitters or the transmitter part of transceivers

Exclusion bands shall not be applied when measuring transmitters in standby mode. When the transmitter is in operating mode the exclusion band extends 250 % of the occupied bandwidth either side of the centre frequency.

NOTE: Exclusion band of 250 % is based on the definition from ITU Radio Regulations [i.3], 1.146, 1.146A and 1.146B and is specified in the Recommendation ITU-R SM.1541-6 [i.5].

For radar systems capable of multi-frequency operation, the total transmitter exclusion band shall be the combination of the exclusion bands for each operating frequency supported by the radar system.

4.3.3 Exclusion band for receivers or the receiver part of the transceivers

The exclusion band shall be calculated by using the following formula:

$$EXband(lower) = 0,95 \times Band_{Rx}(lower)$$

and for the upper edge of the exclusion band:

$$EXband(upper) = 1,05 \times Band_{Rx}(upper)$$

Exclusion bands are not applied when testing emissions of receivers or receiver part of transceivers.

For radar systems capable of multi-frequency operation, the total transmitter exclusion band shall be the combination of the exclusion bands for each operating frequency supported by the radar system.

4.4 Normal test modulation

The test modulation is specified as follows:

- The transmitter shall be modulated with a test signal which represents the normal operation of the equipment for its intended use. The transmitter shall be operated at its maximum rated RF peak output power and maximum possible duty cycle.

NOTE: Due to the different available radar systems and their different operating modes, it is not possible to define for each category of radar system an operating mode.

The characteristics of the applied test modulation shall be recorded in the test report.

5 Performance Assessment

5.1 General requirements

The manufacturer should, at the time of submission of the equipment for test, supply the information required in ETSI EN 301 489-1 [1], annex C. If information is supplied by the manufacturer, it shall be in accordance with the documentation accompanying the equipment and shall be recorded in the test report.

6 Performance criteria

6.1 General requirements

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.
- Performance criteria C for immunity tests with voltage interruptions.

Many radars contain built-in test equipment that can continuously determine the integrity and performance of the radar system and the receive/transmit chains. It is acceptable to use this functionality to help in determining proper function of the EUT and also the transmitter/receiver during and after the test. However it may be necessary to use external measurements to ascertain that the EUT is within its specified operating performance.

Table 2: Performance criteria

Criteria	During test	After test
A	Operate as intended (see note 1) No unintended RF transmission No unintended antenna motion No Degradation of performance (see note 2)	Operate as intended (see note 1) No change of critical stored data No degradation of performance (see note 2)
B	No loss of function No unintended RF transmission No unintended antenna motion Acceptable degradation of performance (see note 3)	Operate as intended (see note 1) No degradation of performance (see note 2) No change of critical stored data
C	Loss of function (one or more) No unintended RF transmission Change of operating mode may occur but no unintended antenna motion and no unintended RF transmission shall start	The intended operating mode shall be recoverable either automatically or by operational user intervention (see note 4) No degradation of performance (see note 2) No change of critical stored data or user programmable functions There shall be no unintentional operation including unwanted activation or deactivation of the transmitter or unintended antenna motion. It also includes switching from one operating mode to another without the interaction of the user
<p>NOTE 1: Where the EUT has more than one mode of operation (including standby mode and operating mode) an unplanned transition from one mode to another is an unintended response.</p> <p>NOTE 2: No degradation of performance means the performance of the EUT remains within the specified limits as stated in the documentation of the EUT without any new warnings or errors.</p> <p>NOTE 3: Acceptable degradation of performance means no degradation below the minimum performance levels specified in annex B of the present document for the use of the EUT as intended.</p> <p>NOTE 4: The EUT combined with its test support equipment should provide an indication of the need for manual operation to recover normal functionality of the EUT. 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>		

7 Applicability tables

7.1 EMC Emission

7.1.1 General requirements

The following emission requirements set out in table 3 shall apply.

The EUT test configuration shall be in accordance with ETSI EN 301 489-1 [1], clause 8.1.2.

Table 3: Emission Requirements

Phenomenon	Port	Applicability	Reference clause
Radiated emission	Enclosure	Applicable	7.1.2
Conducted emission	DC power output	Applicable	ETSI EN 301 489-1 [1], clause 8.3
Conducted emission	AC mains input/output	Applicable	7.1.2
Conducted emission	Wired network	Applicable	ETSI EN 301 489-1 [1], clause 8.7

7.1.2 Special Conditions

The following special conditions set out in table 4 shall apply.

Table 4: Special conditions for EMC emission measurements

Reference to clauses in ETSI EN 301 489-1 [1]	Special product-related conditions, additional to or modifying the test conditions in ETSI EN 301 489-1 [1], clause 8
8.2.3: Limits Enclosure Port	The radiated emissions from the enclosure of the radio equipment shall meet the same requirements as stated for the enclosure of ancillary equipment in ETSI EN 301 489-1 [1], clause 8.2. The relevant exclusion band specified in clause 4.3 shall apply.
8.4.2: Limits AC mains power input/output ports	<ul style="list-style-type: none"> For EUT with an input current up to and including 16A per phase, the limits in ETSI EN 301 489-1 [1], clause 8.4.3 shall apply. For EUT with an input current of greater than 16A per phase, the class A limits given in EN 55032 [i.4], annex A, table A.9 shall apply.

7.2 Immunity

7.2.1 General requirements

The following immunity requirements set out in table 5 shall apply.

In case of multiple mains power input lines, fast transients common mode, RF common mode, voltage dips and interruptions and surge tests shall be separately applied to each mains power input.

Table 5: Immunity Requirements and applicability

Phenomenon	Port	Applicability	Reference clause	Performance Criteria
RF electromagnetic field (80 MHz to 6 000 MHz)	Enclosure	Applicable	7.2.2	A
Electrostatic discharge	Enclosure	Applicable	ETSI EN 301 489-1 [1], 9.3.1 and 9.3.2	B
Fast transients common mode	Signal, wired network and control	Applicable	ETSI EN 301 489-1 [1], 9.4.1 and 9.4.2	B
	DC power	Applicable	ETSI EN 301 489-1 [1], 9.4.1 and 9.4.2	B
	AC power	Applicable	ETSI EN 301 489-1 [1], 9.4.1 and 9.4.2	B
RF common mode 0,15 MHz to 80 MHz	Signal, wired network and control	Applicable	7.2.2	A
	DC power	Applicable	ETSI EN 301 489-1 [1], 9.5.1 and 9.5.2	A
	AC power	Applicable	ETSI EN 301 489-1 [1], 9.5.1 and 9.5.2	A
Voltage dips and interruptions	AC mains power input	Applicable	ETSI EN 301 489-1 [1], 9.7.1 and 9.7.2	C
Surges, line to line and line to ground	AC mains power input	Applicable	ETSI EN 301 489-1 [1], 9.8.1 and 9.8.2	B
	Wired network	Applicable	ETSI EN 301 489-1 [1], 9.8.1 and 9.8.2	B

7.2.2 Special Conditions

The following special conditions set out in table 6 shall apply.

Table 6: Special conditions for EM immunity tests

Reference to clauses in ETSI EN 301 489-1 [1]	Special product-related conditions, additional to or modifying the test conditions in ETSI EN 301 489-1 [1], clause 9
9.2: RF electromagnetic field (80 MHz to 6 000 MHz)	Level of the immunity RF test signal: <ul style="list-style-type: none"> the test level over the frequency range 80 MHz to 1 000 MHz shall be 10 V/m (measured unmodulated); the test level over the frequency range 1 000 MHz to 6 000 MHz shall be 3 V/m (measured unmodulated).
9.5: RF common mode 0,15 MHz to 80 MHz	The conducted RF immunity test described in ETSI EN 301 489-1 [1], clause 9.5 shall be used only, with the test level set to 10 V/m.

Annex A (informative): Relationship between the present document and the essential requirements of Directive 2014/53/EU

The present document has been prepared under the Commission's standardisation request C (2015) 5376 final [i.2] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.1].

Once the present document is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of the present document given in table A.1 confers, within the limits of the scope of the present document, a presumption of conformity with the corresponding essential requirements of that Directive and associated EFTA regulations.

Table A.1: Relationship between the present document and the essential requirements of Directive 2014/53/EU

Harmonised Standard ETSI EN 301 489-54					
Requirement				Requirement Conditionality	
No	Description	Essential requirements of Directive	Clause(s) of the present document	U/C	Condition
1	Emissions: Enclosure port	3.1(b)	7.1	U	
2	Emissions: DC power output ports	3.1(b)	7.1	C	Only where equipment has DC power output ports with a cable length greater than 3 m.
3	Emissions: AC mains power input/output ports	3.1(b)	7.1	U	
4	Emissions: Wired network ports	3.1(b)	7.1	C	Only where equipment has wired network ports.
5	Immunity: Radio frequency electromagnetic field (80 MHz to 6 000 MHz)	3.1(b)	7.2	U	
6	Immunity: Electrostatic discharge	3.1(b)	7.2	U	
7	Immunity: Fast transients common mode	3.1(b)	7.2	C	Only where equipment has AC mains power input ports or other ports intended to be used with cables longer than 3 m.
8	Immunity: Radio frequency common mode	3.1(b)	7.2	C	Only where equipment has AC mains power input ports or other ports intended to be used with cables longer than 3 m.
9	Immunity: Voltage dips and interruptions	3.1(b)	7.2	U	
10	Immunity: Surges, line to line and line to ground	3.1(b)	7.2	U	

Key to columns:

Requirement:

No A unique identifier for one row of the table which may be used to identify a requirement.

Description A textual reference to the requirement.

Essential requirements of Directive

Identification of article(s) defining the requirement in the Directive.

Clause(s) of the present document

Identification of clause(s) defining the requirement in the present document unless another document is referenced explicitly.

Requirement Conditionality:

U/C	Indicates whether the requirement is unconditionally applicable (U) or is conditional upon the manufacturer's claimed functionality of the equipment (C).
Condition	Explains the conditions when the requirement is or is not applicable for a requirement which is classified "conditional".

Presumption of conformity stays valid only as long as a reference to the present document is maintained in the list published in the Official Journal of the European Union. Users of the present document should consult frequently the latest list published in the Official Journal of the European Union.

Other Union legislation may be applicable to the product(s) falling within the scope of the present document.

Annex B (normative): Acceptable Degraded Performance corresponding to Performance Criteria B

The acceptable performance degradation for the EUT under performance criteria B during the test shall be as follows:

- The output power shall not change by more than ± 1 dB outside recorded nominal.
- In the transmitter-on state, there shall be no unintended change in the transmitter frequency:
 - by more than 500 ppm for radar systems operating at frequencies at or below 2 450 MHz, as mentioned in Appendix 2 of ITU Radio Regulations [i.3]; or
 - by more than 1 250 ppm for radar systems operating at frequencies above 2 450 MHz, as mentioned in Appendix 2 of ITU Radio Regulations [i.3].
- Error of a displayed numerical value shall not affect normal operation.
- Communication errors are allowed up to the point where the EUT changes mode of operation or the data stream is interrupted.
- Antenna rotation speed shall not change by more than 10 %.
- The noise floor shall not be raised by more than 6 dB (e.g. as viewed on a PPI monitor).
- In EUT containing a BITE functionality, there may be warnings but no new errors shall be detected.

History

Document history		
V1.0.1	July 2022	EN Approval Procedure AP 20220929: 2022-07-01 to 2022-09-29
V1.1.1	October 2022	Publication