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EUROPEAN STANDARD

**ElectroMagnetic Compatibility (EMC) standard
for marine radio equipment and services;
Part 1: Common technical requirements**

Reference

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Foreword

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

The present document is part 1 of a multi-part deliverable covering the ElectroMagnetic Compatibility (EMC) standard for marine radio equipment and services, as identified below:

Part 1: "Common technical requirements";

Part 2: "Specific conditions for VHF radiotelephone transmitters and receivers operating in the frequency range 156 MHz to 174 MHz";

Part 3: "Specific conditions for non-SOLAS maritime radars and river radars";

Part 4: "Specific conditions for Narrow-Band Direct-Printing (NBDP) NAVTEX receivers";

Part 5: "Specific conditions for MF/HF radiotelephone transmitters and receivers";

Part 6: "Specific conditions for Earth Stations on board Vessels operating in frequency bands above 3 GHz";

Part 7: "Specific conditions for Maritime Broadband Radiolink equipment";

Part 8: "Specific conditions for radio beacons and locating devices".

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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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Introduction

The present document contains a full list of EMC requirements together with the standard test set-ups and compliance limits, that should be used by the product specific parts within the ETSI EN 301 843 series. Deviations, where applicable, from this are set out in the specific product related part.

Product dependent arrangements necessary to perform the EMC tests on dedicated types of radio equipment, and the assessment of test results, are detailed in the appropriate relevant radio technology parts of ETSI EN 301 843 series details of which can be found in the foreword of the present document.

The present document also acts as the basis for product specific parts of the ETSI EN 301 843 series. It is these product specific parts that are intended to be cited in the OJEU under article 3.1(b) of Directive 2014/53/EU [i.8].

1 Scope

The present document contains the common requirements for marine radio communications and radio determination equipment and associated ancillary equipment operating from any combination of internal batteries, DC and single phase AC, in respect of ElectroMagnetic Compatibility (EMC).

The provisions of the present document apply to marine radio equipment **not covered** in the scope of the Council Directive on marine equipment (the "Marine Equipment Directive" 2014/90/EU [i.4]).

Product dependent arrangements necessary to perform the EMC tests on dedicated types of marine radio communications and radio determination equipment, and the assessment of test results, are detailed in the appropriate product related parts of the present document.

The present document, together with the product related part, specifies the applicable EMC tests, the methods of measurement, the limits and the performance criteria for marine radio equipment and associated ancillary equipment.

In case of differences (for instance concerning special conditions, definitions, abbreviation) between the present document and the relevant product related part of the present document, the product related part takes precedence.

For the further content of the present document, the expression "radio equipment" is taken to mean marine radio communications or radio determination equipment, in each individual case.

Technical specifications related to the antenna port of radio equipment and emissions from the enclosure port of radio equipment and combinations of radio and associated ancillary equipment are not included in the present document. Such technical specifications are normally found in the relevant product standards for the effective use of the radio spectrum.

The environment classification used in the present document is maritime, as defined in EN IEC 60945 [i.3].

Marine radio communications equipment meeting the EMC requirements set out in EN IEC 61000-6-3 [i.1] and EN 61000-6-1 [i.2] is deemed to meet also the EMC requirements for the maritime environment described in EN IEC 60945 [i.3].

The EMC requirements have been selected to ensure an adequate level of compatibility for apparatus intended to be used in the maritime environment. The levels, however, do not cover extreme cases which may occur in any location but with low probability of occurrence.

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

- [1] [EN IEC 55016-1-4:2019](#): "Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-4: Radio disturbance and immunity measuring apparatus – Antennas and test sites for radiated disturbance measurements", (produced by CENELEC).
- [2] [EN IEC 55016-1-1:2019](#): "Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-1: Radio disturbance and immunity measuring apparatus - Measuring apparatus", (produced by CENELEC).

- [3] [EN 61000-4-2:2009](#): "Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test", (produced by CENELEC).
- [4] [EN IEC 61000-4-3:2020](#): "Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test", (produced by CENELEC).
- [5] [EN 61000-4-4:2012](#): "Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test", (produced by CENELEC).
- [6] [EN 61000-4-5:2014 +A1:2017](#): "Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test", (produced by CENELEC).
- [7] [EN 61000-4-6:2014](#): "Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields", (produced by CENELEC).
- [8] [EN IEC 61000-4-11:2020](#): "Electromagnetic compatibility (EMC) –Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current up to 16 A per phase", (produced by CENELEC).
- [9] [EN 55016-2-3:2017/A1:2019](#): "Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-3: Methods of measurement of disturbances and immunity - Radiated disturbance measurements", (produced by CENELEC).
- [10] [EN 55016-2-1:2014+A1:2017](#): "Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-1: Methods of measurement of disturbances and immunity - Conducted disturbance measurements", (produced by CENELEC).

2.2 Informative references

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The following referenced documents may be useful in implementing an ETSI deliverable or add to the reader's understanding, but are not required for conformance to the present document.

- [i.1] EN IEC 61000-6-3 (2021): "Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments", (produced by CENELEC).
- [i.2] EN 61000-6-1 (2019): "Electromagnetic compatibility (EMC) - Part 6-1: Generic standards - Immunity for residential, commercial and light-industrial environments", (produced by CENELEC).
- [i.3] EN 60945 (2002) + Corrigendum 1 (2008): "Maritime navigation and radiocommunication equipment and systems - General requirements - Methods of testing and required test results", (produced by CENELEC).
- [i.4] [Directive 2014/90/EU](#) of the European Parliament and of the Council of 23 July 2014 on marine equipment and repealing Council Directive 96/98/EC.
- [i.5] IEC 60050-161 (1990): "International Electrotechnical Vocabulary. Chapter 161: Electromagnetic compatibility".
- [i.6] [CEPT/ERC Recommendation 74-01 \(2021\)](#): "Unwanted emissions in the spurious domain".
- [i.7] IMO Convention: "International Convention for the Safety of Life at Sea (SOLAS)".

[i.8] [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.

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in article 2 of Directive 2014/53/EU [i.8] and the following apply:

ancillary equipment: equipment (apparatus), used in connection with a receiver, transmitter or transceiver is considered as an ancillary equipment (apparatus) if:

- the equipment is intended for use in conjunction with a receiver or transmitter to provide additional operational and/or control features to the radio equipment, (e.g. to extend control to another position or location); and
- the equipment cannot be used on a stand alone basis to provide user functions independently of a receiver 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)

artificial antenna: non-reactive, non-radiating dummy load equal to the nominal impedance of the antenna port

NOTE: For the purpose of EMC tests, the antenna port(s) of the Equipment Under Test (EUT) are terminated with a non-radiating 50 Ω termination (artificial antenna) unless there is a requirement to apply a Radio Frequency (RF) input signal to the receiver antenna port.

Artificial Mains Network (AMN): network used to supply the mains voltage (AC or DC) and current to the Equipment Under Test (EUT)

continuous phenomena (continuous disturbance): electromagnetic disturbance, the effects of which on a particular device or equipment cannot be resolved into a succession of distinct effects

NOTE: See IEC 60050-161 [i.5].

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

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

NOTE: In the case of integral antenna equipment, this port is inseparable from the antenna port.

integral antenna: antenna designed to be connected directly to the equipment with or without the use of an external connector and considered to be part of the equipment

NOTE: An integral antenna may be fitted internally or externally to the equipment. An antenna which may not be removed during the tests, according to the manufacturer's statement.

mobile equipment: marine receiver, transmitter or transmitter/receiver (transceiver) intended for installation and use onboard ships

operating frequency range: range(s) of radio frequencies covered by the Equipment Under Test (EUT) without any change of units

port: particular interface, of the specified equipment (apparatus), with the electromagnetic environment

NOTE: For example, any connection point on an equipment intended for connection of cables to or from that equipment is considered as a port (see Figure 1).

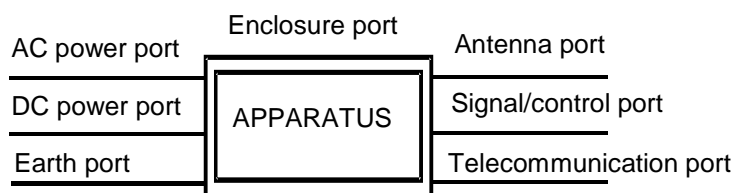


Figure 1: Examples of ports

portable equipment: marine radio and/or ancillary equipment intended for portable (e.g. handheld) operation onboard ships, and powered by its own integral battery

radio communications equipment: radio equipment which includes one or more radio transmitters and/or receivers and/or parts thereof for use in a mobile or portable application onboard ships

radio determination equipment: radio equipment able to determine the position, velocity and/or other characteristics of an object, or the obtaining of information relating to these parameters, by means of the propagation properties of radio waves.

NOTE: This includes navigation radars

radio equipment: "An electrical or electronic product, which intentionally emits and/or receives radio waves for the purpose of radio communication and/or radio determination, or an electrical or electronic product which must be completed with an accessory, such as antenna, so as to intentionally emit and/or receive radio waves for the purpose of radio communication and/or radio determination", definition from Directive 2014/53/EU [i.8].

NOTE: Radio equipment can be operated with ancillary equipment but if so, is not dependent on it for basic functionality.

removable antenna: antenna which may be removed for the test according to the manufacturer statement

spurious emission: emission on a frequency, or frequencies, which are outside the Bn and the level of which may be reduced without affecting the corresponding transmission of information

NOTE: Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products but exclude out of band emissions (CEPT/ERC Recommendation 74-01 [i.6]).

transient phenomena (transient disturbance): pertaining to or designating a phenomena or a quantity which varies between two consecutive steady states during a time interval short compared with the time-scale of interest

NOTE: See IEC 60050-161 [i.5].

worst case: configuration and arrangement of the EUT, ancillary equipment and connecting cables that produces the worst emissions or the lowest immunity during testing

3.2 Symbols

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

Bn	Necessary bandwidth of an emission
PX	Maximum PEP

3.3 Abbreviations

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

AC	Alternating Current
AM	Amplitude Modulation
AMN	Artificial Mains Network
DC	Direct Current
EM	ElectroMagnetic

EMC	ElectroMagnetic Compatibility
EUT	Equipment Under Test
FSOATS	Free Space Open Area Test Site
IEC	International Electrotechnical Commission
IMO	International Maritime Organization
MF/HF	Medium Frequency/High Frequency
NAVTEX	Navigational Telex
NBDP	Narrow Band Direct Printing
PEP	Peak Envelope Power
RF	Radio Frequency
SAC	Semi-Anechoic Chamber
VHF	Very High Frequency

4 General and operational requirements

4.1 Environmental profile

The technical requirements of the present document apply under the environmental profile for operation of the equipment, which shall be in accordance with its intended use, but as a minimum, shall be that specified in the test conditions contained in the present document. The equipment shall comply with all the technical requirements of the present document at all times when operating within the boundary limits of the operational environmental profile defined by its intended use.

The equipment shall be tested under normal test conditions according to the relevant product and basic standards or to the information accompanying the equipment.

The test shall be carried out at a point within the specified normal operating environmental range of temperature and humidity with the equipment connected to the intended power supply voltage. The normal temperature and humidity conditions shall be a combination of temperature and humidity within the following ranges:

- temperature: +15 °C to +35 °C
- relative humidity: 25 % to 75 %

The test voltage for equipment to be connected to the AC mains, shall be the nominal (rated) mains voltage. The frequency of the test voltage shall be 50 Hz and its offset shall not exceed 1 Hz.

The test voltage for equipment to be connected to a battery, shall be the nominal voltage of the battery as specified in the user documentation.

The test conditions, configuration, and mode of operation shall represent the intended use and shall be recorded.

For emission and immunity tests, specific product type related information on the test modulation, test conditions and tests arrangements, etc., are found in the part of the present document dealing with the particular type of radio equipment.

4.2 Arrangements for test signals

4.2.0 General

Standalone receivers and transmitters shall be tested separately. Transceivers shall be tested so that operation in each direction is confirmed.

4.2.1 Arrangements for test signals at the input of transmitters

The signal source providing the transmitter under test with the modulation signal for the normal test modulation shall be located outside the test environment, unless the transmitter is modulated by its own internal source.

4.2.2 Arrangements for test signals at the output of transmitters

The measuring and monitoring equipment for the wanted RF output signal from the transmitter under test shall be located outside the test environment.

For transmitters with an integral antenna, the wanted RF output signal to establish a communication link shall be delivered from the EUT to an antenna located within the test environment. This antenna shall be connected to the external equipment by a coaxial cable.

For transmitters with a removable antenna, the wanted RF output signal to establish a communication link shall be delivered from the antenna connector to the external equipment by a shielded transmission line, such as a coaxial cable.

The level of the wanted RF output signal in transmit mode of operation shall be set to the maximum rated RF power for the EUT.

4.2.3 Arrangements for test signals at the input of receivers

The signal source providing the receiver under test with the wanted RF input signal shall be located outside the test environment.

For receivers with an integral antenna, the wanted RF input signal to establish a communication link shall be presented to the EUT from an antenna located within the test environment. This antenna shall be connected to the external RF signal source by a coaxial cable.

For receivers with a removable antenna, the wanted RF input signal to establish a communication link shall be presented to the antenna connector of the EUT by a shielded transmission line, such as e.g. a coaxial cable. The transmission line shall be connected to the external RF signal source.

The level of the wanted RF input signal is expected to represent a signal level and is intended to avoid the broadband noise from the power amplifiers generating the EM disturbance from influencing the measurement.

4.2.4 Arrangements for test signals at the output of receivers

The measuring and monitoring equipment for the output signal from the receiver under test shall be located outside the test environment.

If the receiver has an output connector or port providing the wanted baseband output signal, then this port should be used in a manner consistent with its intended use.

For receivers without an output connector, thus providing a visual or acoustic indicating of the received signal, this output should be coupled via an electrically non-conductive means to the external equipment.

For receivers with an analogue speech output the audio output from the acoustic transducer, this output should be coupled via an electrically non-conductive acoustic tube to an external audio distortion meter or other measuring equipment as required.

Precautions will need to be taken to ensure that any effect on the test due to the coupling means is minimized.

4.2.5 Arrangements for testing transmitter and receiver together (as a system)

Transmitters and receivers may be tested for immunity as a system when combined as a transceiver or the combined equipment is of a size which allows simultaneous testing. In this case the transceiver or transmitter and receiver shall be located inside the test environment and shall be exposed simultaneously to the immunity test signals.

The test modulation shall be transmitted by the test system and looped back in the EUT. Further, the output of the EUT shall be monitored by the test system.

4.3 RF exclusion band of radio communications equipment

For the purpose of EMC tests set up in the present document, the radio communications or radio determination equipment is subject to an exclusion band.

The RF exclusion band shall apply to radio communications and determination equipment intended for operation at designated frequencies up to 6 GHz.

Particular care is required for radio equipment intended for operation at designated frequencies less than or equal to 30 MHz. Under these circumstances the RF exclusion band shall apply to EMC emission measurements and immunity tests for conducted disturbances at AC mains and/or DC power ports which are performed in the frequency range up to 30 MHz.

The following provisions shall apply to all types of radio equipment:

- transmitters and transceivers:
 - the RF exclusion band applies to EMC emission measurements in transmit mode of operation, and to immunity tests. For equipment in stand-by mode, the exclusion band for transmitters shall not apply to EMC emission measurements;
- receivers:
 - the RF exclusion band applies to immunity tests only;
- ancillary equipment:
 - for ancillary equipment intended to be tested on a stand alone basis, an RF exclusion band does not apply;
 - for ancillary equipment intended to be tested in combination with radio equipment the provisions above for transmitters and/or receivers apply.

4.4 Intermediate frequency responses of receivers or receivers which are part of transceivers

Responses on receivers or the receiver part of (duplex) transceivers occurring during the immunity tests at discrete frequencies which are narrow band responses (spurious responses), are identified by the following method:

- If during the test, the immunity RF test signal (see clauses 9.2 and 9.5) causes non-compliance of the receiver with the specified performance criteria for continuous phenomena (see clause 6.1), it is necessary to identify whether this non compliance is due to a narrow band response or a wideband phenomenon. For narrow band phenomenon the frequency of the disturbance signal is increased by an amount equal to twice the nominal 6 dB bandwidth of the filter immediately preceding the demodulator of the receiver. For wideband phenomenon the frequency of the disturbance signal is increased by an amount equal to the bandwidth over which the apparatus is intended to operate. The test is repeated with the frequency of the test signal decreased by the same amount.
- If the receiver is then in either or both frequency offset cases in compliance with the specified performance criteria, the response is considered as a narrow band response.
- If the receiver still does not comply with the specified performance criteria, this may be due to the fact that the offset has made the frequency of the unwanted signal correspond to the frequency of another narrow band response. Under these circumstances, the procedure is repeated with a positive and negative offset of the frequency of the disturbance signal adjusted two and a half times the bandwidth referred to above.
- If the receiver still does not comply with the specified performance criteria in either or both frequency offset cases, the phenomena is considered wideband and therefore an EMC problem and the equipment fails the test.

For immunity tests, narrow band responses shall be disregarded.

4.5 Void

5 Performance assessment

5.1 General

At the time of submission of the equipment for test, the manufacturer supplies all relevant technical information to establish the functionality of the EUT including the following:

- the intended functions of the radio equipment which shall be in accordance with the documentation accompanying the equipment;
- the antenna type of the radio equipment (integral or removable antenna);
- the user control functions and stored data that are required for normal operation and the method to be used to assess whether these have been lost after the EMC exposure;
- the type of modulation, the characteristics of the transmission used for testing (random bit stream, message format, etc.) and the necessary test equipment delivered to enable the assessment of the EUT;
- the maximum rated RF output power of transmitters;
- the ancillary equipment to be combined with the radio equipment for testing (where applicable);
- the ancillary equipment intended to be tested on a stand alone basis (where applicable);
- an exhaustive list of ports, with the maximum cable lengths allowed, classified as either power (AC/DC) or telecommunication/signal/control;
- the bandwidth of the filter immediately preceding the demodulator;
- the operating frequency bands over which the equipment is intended to operate.

The following information should be included in the test report:

- the primary functions of the EUT exercised during and after EMC immunity test;
- the other functions of the EUT in accordance with the documentation accompanying the equipment;
- the method of monitoring the actual level of performance and/or the actual degradation of performance of the EUT.

5.2 Equipment which can provide a continuous communication link

A communication link shall be established to the measuring equipment for the wanted RF output signal from the EUT, or from the RF signal source providing the EUT with the wanted RF input signal, at the start of the test, and its performance shall be assessed during and after the immunity tests, as specified in clause 6 and its subclauses. The SINAD performance shall be monitored for analogue communications, and the Bit Error Rate shall be monitored for digital communications.

5.3 Equipment which does not provide a continuous communication link

A communication link shall be established to the measuring equipment for the wanted RF output signal from the EUT, or from the RF signal source providing the EUT with the wanted RF input signal, at the start of the test, and its

performance shall be assessed during and after the immunity tests, as specified in clause 6 and its subclauses. The packet error rate shall be monitored.

5.4 Ancillary equipment

For immunity tests of ancillary equipment tested on a stand alone basis the permissible minimum level of performance or the permissible degradation of performance during and/or after the EMC exposure is specified in the relevant part of this multi part deliverable. The related specifications set out in clause 5.3 also apply.

For immunity tests of ancillary equipment tested in combination with the radio equipment and not having separate pass/fail criteria, the receiver, transmitter or transceiver coupled to the ancillary equipment shall be used to assess whether the ancillary equipment passes or fails the test.

5.5 Equipment classification

For the purpose of the EMC performance assessment in the present document, the marine radio equipment and/or associated ancillary equipment under test shall be classified into one of the following two classes:

- mobile equipment;
- portable equipment.

Portable marine radio and/or ancillary equipment or combinations thereof capable of being powered for intended use by the internal AC or DC mains supply onboard ships shall additionally be considered as mobile equipment.

For multiple use (mobile and portable), marine radio and/or ancillary equipment both sets of tests shall be applied.

6 Performance criteria

6.0 General requirements

The performance criteria are used to take a decision on whether a radio equipment passes or fails immunity tests.

The establishment of the communication link at the start of the test, its maintenance and the assessment of the recovered signal are used as performance criteria for the evaluation of the essential functions of the radio equipment during and after the test.

Portable marine equipment powered by the internal AC/DC supply onboard ships shall in addition fulfil the requirements specified in the present document for mobile equipment.

For the purpose of the present document three categories of performance criteria are defined:

- performance criteria A for continuous phenomena applied to transmitters and receivers;
- performance criteria B for transient phenomena applied to transmitters and receivers; and
- performance criteria C applied to power supply failure.

Table 1 summarize the performance criteria.

Table 1: Performance criteria

Criteria	During test	After test (i.e. as a result of the application of the test)
A	Shall operate as intended. (See note). Shall be no loss of function. Shall be no unintentional transmissions.	Shall operate as intended. Shall be no degradation of performance. Shall be no loss of function. Shall be no loss of critical stored data.
B	May be loss of function. Shall be no unintentional transmissions.	Functions shall be self-recoverable. Shall operate as intended after recovering. Shall be no loss of critical stored data.
C	May be loss of function. Shall be no unintentional transmissions.	Functions shall be recoverable by the operator. Shall operate as intended after recovering. Shall be no loss of critical stored data.
NOTE:	Operate as intended during the test shall be considered as: <ul style="list-style-type: none"> For equipment that supports a PER or FER, the minimum performance level shall be a PER or FER less than or equal to 10 %. For equipment that does not support a PER or a FER, (e.g. audio equipment and equipment transmitting sporadic messages) the minimum performance level shall be no loss of the wireless transmission function needed for the intended use of the equipment. 	

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

During and after the test, the apparatus shall continue to operate as intended. No degradation of performance or loss of function is allowed. See Table 1.

The EUT shall meet the requirements of the performance check during and after the test.

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

Any degradation of performance or loss of function is allowed below a permissible performance level as defined in the immunity performance check, provided that the EUT recovers following the test. Before and after the test, the apparatus shall operate as intended. See Table 1.

The EUT shall meet the requirements of the performance check after the test.

NOTE: For example if the EUT resets during the test it will immediately recover after the test to same state and condition as before the test.

6.3 Performance criteria C applied to power supply failure

During the test sequence the EUT shall not unintentionally transmit or change critical stored data. See Table 1.

The EUT shall meet the requirements of the performance check.

6.4 Void

6.5 Performance criteria for equipment which does not provide a continuous communication link

The provisions defined in clause 5.3 shall apply.

6.6 Performance criteria for ancillary equipment tested on a stand alone basis

The provisions defined in clause 5.4 shall apply.

7 Applicability

The applicability of EMC tests specified in the present document depends on the actual type of marine radio and/or associated ancillary equipment under test. All tests are port-related EMC tests. For EUT not having a particular type of port the related EMC tests do not apply.

Signal and control ports intended for connection to lines which may carry power shall be assessed only as signal and control ports.

All ports of the equipment shall be actively exercised during tests.

In the case of multiple radio and ancillary equipment, the worst case scenario shall be tested.

8 Testing for compliance with technical requirements

8.1 Test configuration

The requirements for test configurations are as follows:

- the measurements shall be carried out at a point within the specified normal operating environmental range and at the rated supply voltage for the equipment;
- the 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 operation;
- the radiated emission shall be maximized, e.g. by moving the cables of the equipment;
- where radio equipment is provided with a detachable antenna, it shall be tested with the antenna fitted in the manner typical of normal intended use;
- if the equipment is part of a system, or can be connected to ancillary equipment, the equipment shall be tested while connected to the minimum representative configuration of ancillary equipment necessary to exercise all the different types of ports available;
- if the equipment has multiple ports of the same type, then at least half shall be selected to simulate actual operational conditions;
- ports which in normal operation are exercised, 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 recorded.

8.2 Enclosure emissions

8.2.0 Applicability

This test shall be applicable to ancillary equipment not incorporated in the radio equipment and measured on a stand alone basis, and to a radio or combinations of radio and ancillary equipment together as a system. Radiated emission testing is not required for radio equipment without any ancillary equipment as this is covered by the appropriate standard under article 3.2 of Directive 2014/53/EU [i.8].

This test shall be performed on a worst case configuration.

8.2.1 Test description

This test assesses the ability of the equipment to limit its internal noise from being radiated from the enclosure.

8.2.2 Test method

The test method shall be in accordance with EN 55016-2-3[9] clause 7.11 for frequencies from 150 kHz to 30 MHz, clause 7.3 for frequencies from 30 MHz to 1 GHz and clause 7.6 for frequencies from 1 GHz to 6 GHz with the modifications specified hereafter.

The measurement distance between the centre of the test antenna and the EUT shall be 3 m. The test site to be used shall be as follows:

- The SAC test site in accordance with EN IEC 55016-1-4 [1] clause 5 for $150 \text{ kHz} \leq f \leq 30 \text{ MHz}$.
- The SAC test site in accordance with EN IEC 55016-1-4 [1] clause 6 for $30 \text{ MHz} < f \leq 1 \text{ GHz}$.
- The FSOATS test site in accordance with EN IEC 55016-1-4 [1] clause 7 for $1 \text{ GHz} < f \leq 6 \text{ GHz}$.

The measuring bandwidth shall be in accordance with Table 2.

Table 2: Measuring bandwidth - radiated emissions

Frequency range	Measuring bandwidth
$150 \text{ kHz} \leq f \leq 30 \text{ MHz}$	9 kHz
$30 \text{ MHz} < f \leq 156 \text{ MHz}$	120 kHz
$156 \text{ MHz} < f \leq 165 \text{ MHz}$	9 kHz
$165 \text{ MHz} < f \leq 2 \text{ GHz}$	120 kHz
$2 \text{ GHz} < f \leq 6 \text{ GHz}$	1 MHz

For measurement equipment that does not support the 120 kHz measurement bandwidth between 1 GHz and 2 GHz a measurement bandwidth of 100 kHz shall be used instead applying the following amplitude correction factor:

Measured amplitude correction factor = $10 \times \log_{10} (120 / 100)$ dB, which is added to the measurement.

When the EUT consists of more than one unit the interconnecting cables shall have the maximum length and type as stated in the user documentation. Available input and output ports of the equipment under test shall be connected to the maximum length of cable as stated in the user documentation and terminated to simulate the impedance of the relevant ports of the radio equipment. These cables shall be bundled at the approximate centre of the cable with the bundles of 30 cm to 40 cm in length running in the horizontal plane from the port to which it is connected. If it is impractical to do so because of cable bulk or stiffness, the disposition of the excess cable shall be precisely noted in the test report.

The emissions shall be measured in the frequency range of 150 kHz to 6 GHz using the measuring receiver described in EN IEC 55016-1-1 [2] clause 5 for $150 \text{ kHz} \leq f \leq 2 \text{ GHz}$ and clauses 6 and 7 for $2 \text{ GHz} < f \leq 6 \text{ GHz}$.

Carrier frequency emissions (including out of band emissions) and associated harmonics from radio equipment when tested as part of a system shall be ignored as these are covered by the appropriate standard under article 3.2 of Directive 2014/53/EU [i.8]. Care should be taken to ensure that carrier frequency emissions do not overload the input of the test receiver, for example by replacing removable antennas with dummy loads.

The equipment shall meet both, the quasi peak and the peak emission limits set out in Table 3. The correction factor for the antenna shall include the factor +51,5 dB to convert the magnetic field strength to equivalent electric field strength.

8.2.3 Limits

The levels of field strength of any radiated emission from the enclosure of the EUT in the frequency range 150 kHz to 2 GHz shall not exceed the values given in Table 3 and Figure 2 below.

Table 3: EMC emission limits

Frequency range	Limit (Quasi Peak)	Limit (Peak)	Limit (Average)
150 kHz \leq f \leq 300 kHz	80 dB μ V/m to 52 dB μ V/m	not applicable	not applicable
300 kHz < f \leq 30 MHz	52 dB μ V/m to 34 dB μ V/m	not applicable	not applicable
30 MHz < f \leq 156 MHz	54 dB μ V/m	not applicable	not applicable
156 MHz < f \leq 165 MHz	24 dB μ V/m	not applicable	not applicable
165 MHz < f \leq 2 GHz	54 dB μ V/m	not applicable	not applicable
2 GHz < f \leq 3 GHz	not applicable	70 dBuV/m (see note 2)	50 dBuV/m
3 GHz < f \leq 6 GHz	not applicable	74 dBuV/m (see note 2)	54 dBuV/m

NOTE 1: These limits are specified in EN 60945 [i.3], Table 5 for frequencies up to 2 GHz and EN IEC 61000-6-3 [i.1] for frequencies above 2 GHz.

NOTE 2: Between 2 GHz and 6 GHz, both the peak and average limits shall apply.

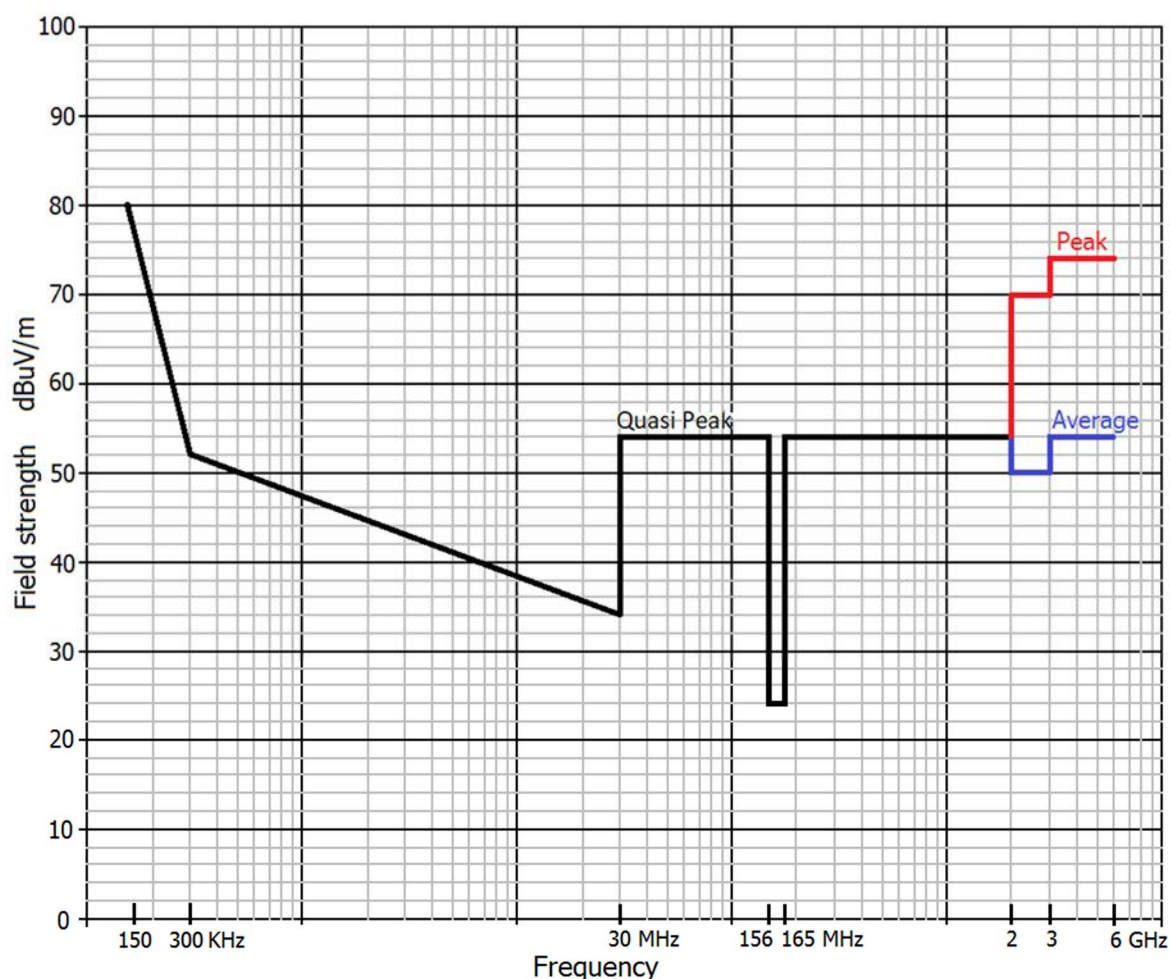


Figure 2: EMC emission limits

8.3 DC power input/output ports

8.3.0 Applicability

This test is applicable to mobile marine radio and ancillary equipment for use onboard ships and intended to be powered by the ship's internal DC supply.

If the DC power cable of the radio and/or the ancillary equipment is intended only for direct connection to a dedicated AC to DC power supply, then the measurement shall be performed on the AC power input of that power supply only as specified in clause 8.4.2.

8.3.1 Test description

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

8.3.2 Test method

The test method shall be in accordance with EN 55016-2-1 [10], clause 7 with the modifications specified hereafter.

This test shall be performed on the EUT. For transceivers, both the receive and the transmit mode of operation shall be tested.

If the EUT consists of more than one unit with individual DC power input ports, power input ports of identical nominal supply voltages shall be connected in parallel to the artificial mains network.

The measurement frequency range extends from 10 kHz to 30 MHz. The measuring bandwidth shall be:

- 200 Hz in the frequency range 10 kHz to 150 kHz; and
- 9 kHz in the frequency range 150 kHz to 30 MHz.

The artificial mains networks for tests shall be as in Figure 4 for $10 \text{ kHz} \leq f \leq 150 \text{ kHz}$ and Figure 5 for $150 \text{ kHz} < f \leq 30 \text{ MHz}$.

8.3.3 Limits

The level (quasi-peak) of any conducted spurious signal shall not exceed the values given in Figure 3.

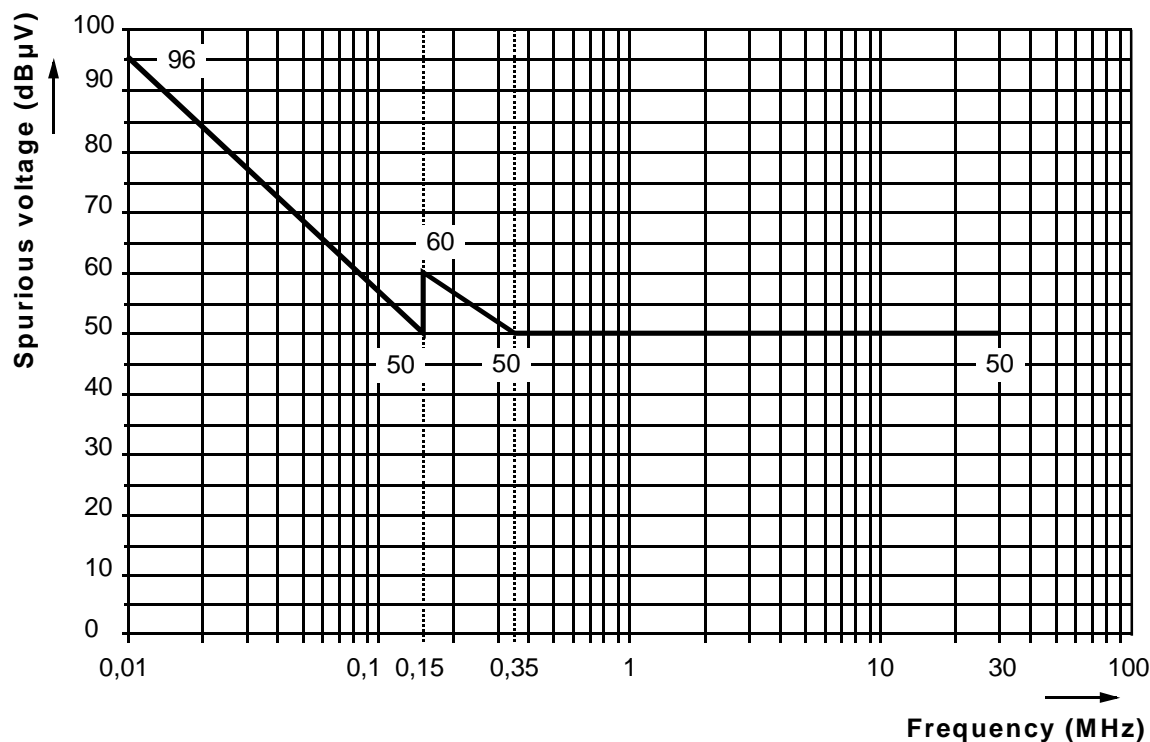


Figure 3: Maximum permissible level (quasi-peak) of conducted EMC emissions into the mains

8.4 AC mains power input/output ports

8.4.0 Applicability

This test shall be applicable to mobile marine radio and ancillary equipment for use onboard ships and powered by the ship's internal AC mains.

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

This test shall be performed on ancillary equipment not incorporated in the radio equipment and measured on a stand alone basis, and to a radio or combinations of radio and ancillary equipment.

8.4.1 Test description

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

8.4.2 Test method

The test method shall be in accordance with EN 55016-2-1 [10], clause 7 with the modifications specified in this clause 8.4.2.

This test shall be performed on the EUT. For transceivers, both the receive and the transmit mode of operation shall be tested.

The power input cable(s) between AC input ports of the EUT and the Artificial Mains Network (AMN) shall be screened and not exceed 0,8 m in length.

If the EUT consists of more than one unit with individual AC power input ports, power input ports of identical nominal supply voltages shall be connected in parallel to the artificial mains network.

The measurement frequency range extends from 10 kHz to 30 MHz. The measuring bandwidth shall be:

- 200 Hz in the frequency range $10 \text{ kHz} \leq f \leq 150 \text{ kHz}$; and
- 9 kHz in the frequency range $150 \text{ kHz} < f \leq 30 \text{ MHz}$.

The artificial mains networks for tests shall be as in Figure 4 for $10 \text{ kHz} \leq f \leq 150 \text{ kHz}$ and Figure 5 for $150 \text{ kHz} < f \leq 30 \text{ MHz}$.

When the EUT is a transmitter operating at frequencies below 30 MHz, then the exclusion band for transmitters applies (see clause 4.3) for measurements in the transmit mode of operation.

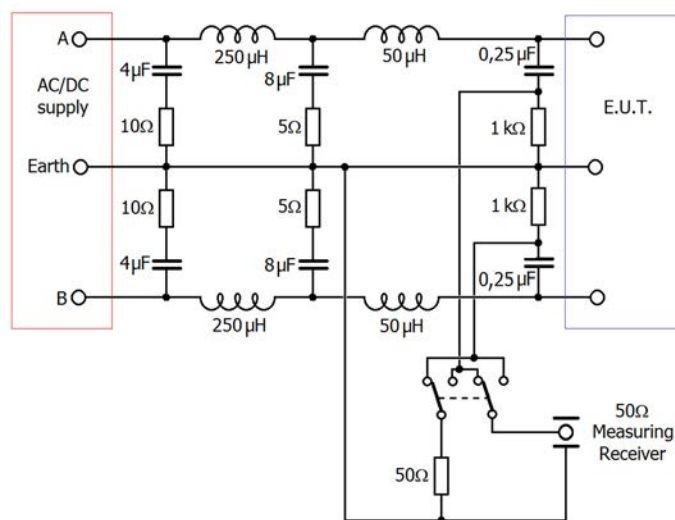


Figure 4: Artificial mains network for tests in the frequency range $10 \text{ kHz} \leq f \leq 150 \text{ kHz}$

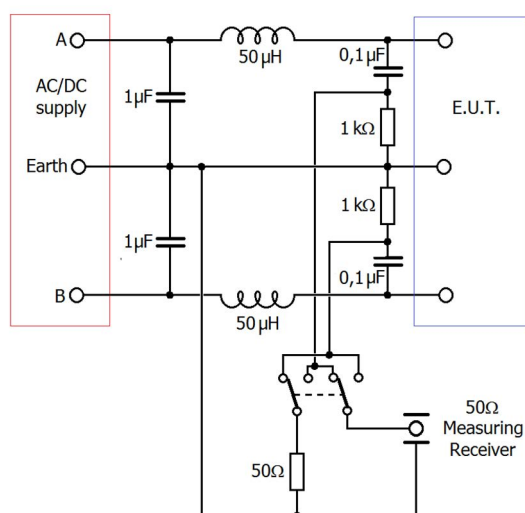


Figure 5: Artificial mains network for tests in the frequency range $150 \text{ kHz} < f \leq 30 \text{ MHz}$

8.4.3 Limits

The level (quasi-peak) of any conducted spurious signal shall not exceed the values given in clause 8.3.3, Figure 3.

9 Test methods and levels for immunity tests

9.0 General

For the immunity tests of transmitters, the transmitter shall be operated at its maximum rated RF output power, modulated with normal test modulation

For the immunity tests of receivers, the wanted RF input signal, coupled to the receiver, shall be modulated with normal test modulation.

For transceivers, the tests shall be performed in both receive and transmit mode of operation. During the tests with continuous EMC phenomena (conducted and radiated RF immunity tests) the exclusion band for receivers and/or transmitters shall apply (see clause 4.3).

9.1 Test configuration

This clause defines the requirements for test configurations:

- the tests shall be carried out at a point within the specified normal operating environmental range and at the rated supply voltage for the equipment;
- if the equipment is part of a system, or can be connected to ancillary equipment, the equipment shall be tested while connected to the minimum representative configuration of ancillary equipment necessary to exercise all the different types of ports available;
- where radio equipment is provided with a detachable antenna, it shall be tested with the antenna fitted in a manner typical of intended use;
- for equipment with multiple ports of different types, a minimum of one of each type shall be connected;
- 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;
- ports which are not connected to cables during normal intended operation, e.g. service connectors, programming connectors, temporary connectors etc. shall not be connected to any cables for the purpose of EMC testing;
- the configuration and mode of operation during the tests shall be recorded.

9.2 Radio frequency electromagnetic field (80 MHz to 6 GHz)

9.2.0 Applicability

This test is applicable to mobile and portable marine radio equipment and associated ancillary equipment.

This test shall be performed on the radio equipment, the associated ancillary equipment, or the worst case combination of radio and ancillary equipment.

9.2.1 Test description

This test assesses the ability of the EUT to operate as intended in the presence of a radio frequency electromagnetic field disturbance.

9.2.2 Test method

The test method shall be in accordance with EN IEC 61000-4-3 [4] clauses 7 and 8 with the modifications specified in this clause below.

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 (AM) to a depth of 80 % by a sinusoidal audio signal of 400 Hz;
- the test shall be performed over the frequency range 80 MHz to 6 GHz with the exception of the exclusion band for transmitters and receivers and duplex transceivers (see clause 4.3);
- a step size of 1 % shall be used. The dwell time shall be set to a minimum of 0,5 s. The dwell time shall be set to give a sweep rate slow enough to allow the detection of any malfunction of the EUT, refer to annex A for guidance on setting the dwell time;
- the frequencies selected and used during the test shall be recorded.

9.2.3 Performance criteria

The performance criteria A for continuous phenomena shall apply (see clause 6.1).

The provisions of the performance check for transmitters and/or receivers shall apply during and after the test.

Responses on receivers occurring at discrete frequencies which are narrow band responses, shall be disregarded from the test (see clause 4.4).

9.3 Electrostatic discharge

9.3.0 Applicability

This test shall be applicable to mobile and portable marine radio equipment and associated ancillary equipment.

This test shall be performed on the radio equipment, the associated ancillary equipment, or the worst case combination of radio and ancillary equipment.

9.3.1 Test description

This test assesses the ability of the EUT to operate as intended in the event of an electrostatic discharge.

9.3.2 Test method

The test method shall be in accordance with EN 61000-4-2 [3] clauses 7 and 8 with the modifications specified in this clause below.

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 6 kV and for air discharge 8 kV. All the intermediate test levels as specified EN 61000-4-2 [3], clause 5, Table 1 shall be performed.

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.

9.3.3 Performance criteria

The performance criteria B for transient phenomena shall apply (see clause 6.2).

The provisions of the performance check for transmitters and/or receivers shall apply after the test.

9.4 Fast transients, differential and common mode

9.4.0 Applicability

This test shall be applicable to mobile marine radio equipment and associated ancillary equipment.

This test shall be performed on the AC power ports of the radio equipment and associated ancillary equipment.

This test shall be additionally performed on signal and control ports and DC power ports (common mode only), if the cables they are connected to are longer than 2 m.

Where this test is not carried out on any port because the EUT is not intended to be used with cables longer than 2 m, a list of ports which were not tested for this reason shall be recorded.

This test shall be performed on the radio equipment, the associated ancillary equipment, or the worst case combination of radio and ancillary equipment.

9.4.1 Test description

This test assesses the ability of the EUT to operate as intended in the event of fast transients present on one of the input/output ports.

9.4.2 Test method

The test method shall be in accordance with EN 61000-4-4 [5] clauses 7 and 8 with the modifications specified in this clause below.

A test generator complying with clause 6.2 of EN 61000-4-4 [5] shall be used. The induction of the interference shall be applied to:

- AC/DC power ports by a coupling/decoupling network complying with clause 6.3 of EN 61000-4-4 [5];
- signal and control ports by a capacitive coupling clamp complying with clause 6.4 of EN 61000-4-4 [5].

The test level shall be 2 kV differential mode on AC mains power ports, and 1 kV common mode on DC power ports and signal and control ports. The test pulses shall comply with the following requirements:

- rise time: 5 ns (value between 10 % and 90 %)
- width: 50 ns (50 % value)
- repetition rate: 5 kHz (1 kV), 2,5 kHz (2 kV)
- application: 15 ms burst every 300 ms
- duration: 3 min to 5 min for each of positive and negative polarity pulses

9.4.3 Performance criteria

The performance criteria B for transient phenomena shall apply (see clause 6.2).

The provisions of the performance check for transmitters and/or receivers shall apply after the test.

9.5 Radio frequency, common mode

9.5.0 Applicability

This test shall be applicable to mobile marine radio equipment and associated ancillary equipment.

This test shall be performed on the AC power input ports of the radio equipment and associated ancillary equipment.

This test shall be additionally performed on signal and control ports and DC power ports of radio equipment and associated ancillary equipment.

Where this test is not carried out on any port because the EUT's ports is not capable of being tested or is not used in normal operation a list of ports which were not tested for this reason shall be recorded in the test report.

This test shall be performed on the radio equipment, the associated ancillary equipment, or the worst case combination of radio and ancillary equipment.

9.5.1 Test description

This test assesses the ability of the EUT to operate as intended in the presence of a radio frequency electromagnetic disturbance on the input/output ports.

9.5.2 Test method

The test method shall be in accordance with EN 61000-4-6 [7], clauses 7 and 8 with the modifications specified in this clause below.

The following requirements and evaluation of test results shall apply:

- the test signal shall be applied to the AC or DC power supply line by a coupling/decoupling network as shown in Figure 5 using the principles described in clause 6.2.1 of EN 61000-4-6 [7];
- For the first test, the test frequency shall be swept and the level shall be 3 V rms unmodulated. The test signal shall then be Amplitude Modulated (AM) to a depth of 80 % by a sinusoidal audio signal of 400 Hz; the test shall be performed over the frequency range 150 kHz to 80 MHz with the exception of an exclusion band for transmitters, for receivers, or duplex transceivers, (see clause 4.3); the frequency range shall be swept at a rate not exceeding $1,5 \times 10^{-3}$ decades per second;
- For the second test, spot frequencies shall be tested with a test level of 10 V rms as follows:
 - 2 MHz, 3 MHz, 4 MHz, 6,2 MHz, 8,2 MHz, 12,2 MHz, 16,5 MHz, 18,8 MHz, 22 MHz and 25 MHz;
- the frequencies of the immunity test signal selected and used during the test shall be recorded.

9.5.3 Performance criteria

The performance criteria A for continuous phenomena shall apply (see clause 6.1).

The provisions of the performance check for transmitters and/or receivers shall apply during and after the test.

Responses on receivers occurring at discrete frequencies which are narrow band responses, shall be disregarded from the test (see clause 4.4).

9.6 Power supply variations

9.6.0 Applicability

These tests shall be applicable to mobile marine radio equipment and associated ancillary equipment using AC power.

These tests shall be performed on the AC power port of radio equipment and associated ancillary equipment.

These tests shall be performed on the radio equipment, the associated ancillary equipment, in the worst case combination.

9.6.1 Power supply short term variations

9.6.1.1 Test description

These tests assess the ability of the EUT to operate as intended when being subjected to power supply short term variations present on the AC power input ports.

9.6.1.2 Test method

The test set-up shall be in accordance with EN IEC 61000-4-11 [8], clause 7 using the configuration given in Figure C.1 b) of annex C and with the modifications specified in this clause below. The test procedure shall be in accordance with EN IEC 61000-4-11 [8], clause 8 for single phase equipment.

The EUT shall be subject to the following power supply variations relative to the nominal value once per minute for the duration of 10 minutes each:

- a) test voltage between 1,19 and 1,21 times nominal voltage for a duration between 1,3 s and 1,7 s;
test frequency between 1,05 and 1,15 times nominal frequency for a duration between 4,5 s and 5,5 s;
the test voltage and the test frequency variations shall be started simultaneously;
- b) test voltage between 0,792 and 0,808 times nominal voltage for a duration between 1,3 s and 1,7 s;
test frequency between 0,855 and 0,945 times nominal frequency for a duration between 4,5 s and 5,5 s;
the test voltage and the test frequency variations shall be started simultaneously.

The voltage and frequency variation rise (10 % to 90 %) and decay (90 % to 10 %) times shall be between 0,1 s and 0,3 s.

9.6.1.3 Performance criteria

The performance criteria B for transient phenomena shall apply (see clause 6.2).

The provisions of the performance check for transmitters and/or receivers shall apply after the test.

9.6.2 Power supply failure

9.6.2.1 Test description

This test assesses the ability of the EUT to operate as intended after recovery from being subjected to short breaks in the power supply due to power supply change over and breaker dropout. It covers the break allowed by the IMO Convention [i.7] for changeover between ships main and emergency power supplies.

9.6.2.2 Test method

The EUT shall be subjected to three breaks in the power supply of a duration of 60 s each.

9.6.2.3 Performance criteria

Performance criterion C, clause 6.3 shall apply.

The provisions of the performance check for transmitters and/or receivers shall apply after the test.

9.7 Surges

9.7.0 Applicability

This test shall be applicable to mobile marine radio equipment and associated ancillary equipment.

These tests shall be performed on the AC power input port of radio equipment and associated ancillary equipment.

These tests shall be performed on the radio equipment, the associated ancillary equipment in the worst case combination.

9.7.1 Test description

This test assesses the ability of the EUT to operate as intended in the event of surges present on the AC power input ports.

9.7.2 Test method

The test method shall be in accordance with EN 61000-4-5 [6] clauses 7 and 8 with the modifications specified in this clause below.

A combination wave (hybrid) generator complying with clause 6.2 of EN 61000-4-5 [6] in combination with the coupling networks shown in Figures 5 and 6 of EN 61000-4-5 [6] shall be used. For equipment using a protective earth connection, the coupling network of Figure 6 shall be used. For all other equipment the coupling network of Figure 5 shall be used.

The following requirements and evaluation of test results shall apply:

- The test voltage shall be applied with a repetition rate of 6 pulses/min for a duration of 5 minutes for each of the positive and negative polarity of the test voltages applied line-to-earth and line-to-line. Pulses with the following characteristics shall be applied:
 - rise time: 1,2 μ s (value between 10 % and 90 %)
 - width: 50 μ s (50 % value)
 - amplitude: 1 kV line/earth, 0,5 kV line/line
 - repetition rate: 1 pulse/min
 - application: continuous

9.7.3 Performance criteria

The performance criteria B for transient phenomena shall apply (see clause 6.2).

The provisions of the performance check for transmitters and/or receivers shall apply after the test.

Annex A (informative): Guidance on setting the dwell time for radiated immunity testing

A.1 Overview

In order to allow the detection of any malfunction of the EUT during radiated immunity testing the sweep rate employed should be slow enough to avoid missing a potential failure. Slowing the sweep rate is achieved by increasing the dwell time whilst keeping the sweep step size constant. For equipment that relies on a continuous link, a test house will typically exercise the EUT to determine how long it takes to report link loss and use this as the dwell time. Applying this rule however often leads to excessive testing time and cost. This annex describes a method for setting the dwell time based on the Q factor of the spurious LRC circuits within the EUT that resonate and generally cause failures during radiated immunity testing.

A.2 Example of EUT containing a GNSS receiver

GNSS receivers are getting more complex as they have to operate with increasingly more constellations. Modern receivers will operate with GPS, GLONASS, Galileo and Beidou simultaneously. As a result the time commercially available modules take to report loss of lock when a GNSS signal is inhibited has become significant. This 'loss of lock' reporting time is the time it takes for a GNSS module to determine that it can not see sufficient satellites in any constellation to maintain a position fix.

Definitions:

- T_{LL} = the lost-lock reporting time of a GNSS module
- F_s = frequency step used in continuous immunity testing (1% or 0,01)
- T_d = dwell time used in continuous immunity testing
- Q_{max} = maximum Q factor able to be detected by a given T_d

Setting $T_d = T_{LL}$ will allow resonances with a Q factor up to $Q = 1 / F_s$ to be detected.

Where the $F_s = 1\%$ then detection of resonances up to $Q = 100$ is possible. However Q factors of 100 are not typical of LRC circuits, parasitic or intended. Q factors of 100 are characteristic of engineered crystal or ceramic filters.

Setting the dwell time to a fraction of the lost-lock reporting time will allow the detection of resonances up to a given Q factor set out in equation A.1:

$$T_d = T_{LL} \times F_s \times Q_{max} \quad (A.1)$$

It can be argued that a reasonable upper limit (Q_{max}) for LRC circuits is 30, in which case the dwell time T_d should be set to 30 % of the lock time T_{LL} .

Annex B (informative): Bibliography

- [Directive 2014/30/EU](#) of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility.

Annex C (informative): Change history

Version	Information about changes
2.1.1	First version under the Radio Equipment Directive
2.2.1	Minor revisions in 2017
2.3.1	Extended the EMC testing requirement up to 6 GHz. Updated all references to latest CENELEC and CISPR standards and revised the text in clauses 8 and 9 accordingly. Moved the emissions and immunity tables from section 7 into the revised product specific subparts. Moved annex A "Relationship between the present document and the essential requirements of Directive 2014/53/EU" to the revised product specific subparts. Added new annex A for guidance on setting the dwell time for radiated immunity testing with an example.

History

Version	Date	Status
V1.1.1	February 2001	Publication
V1.2.1	June 2004	Publication
V1.3.1	August 2012	Publication
V2.1.1	March 2016	Publication
V2.2.1	November 2017	Publication
V2.3.0	December 2025	EN Approval Procedure AP 20260318: 2025-12-18 to 2026-03-18
V2.3.1	March 2026	Publication