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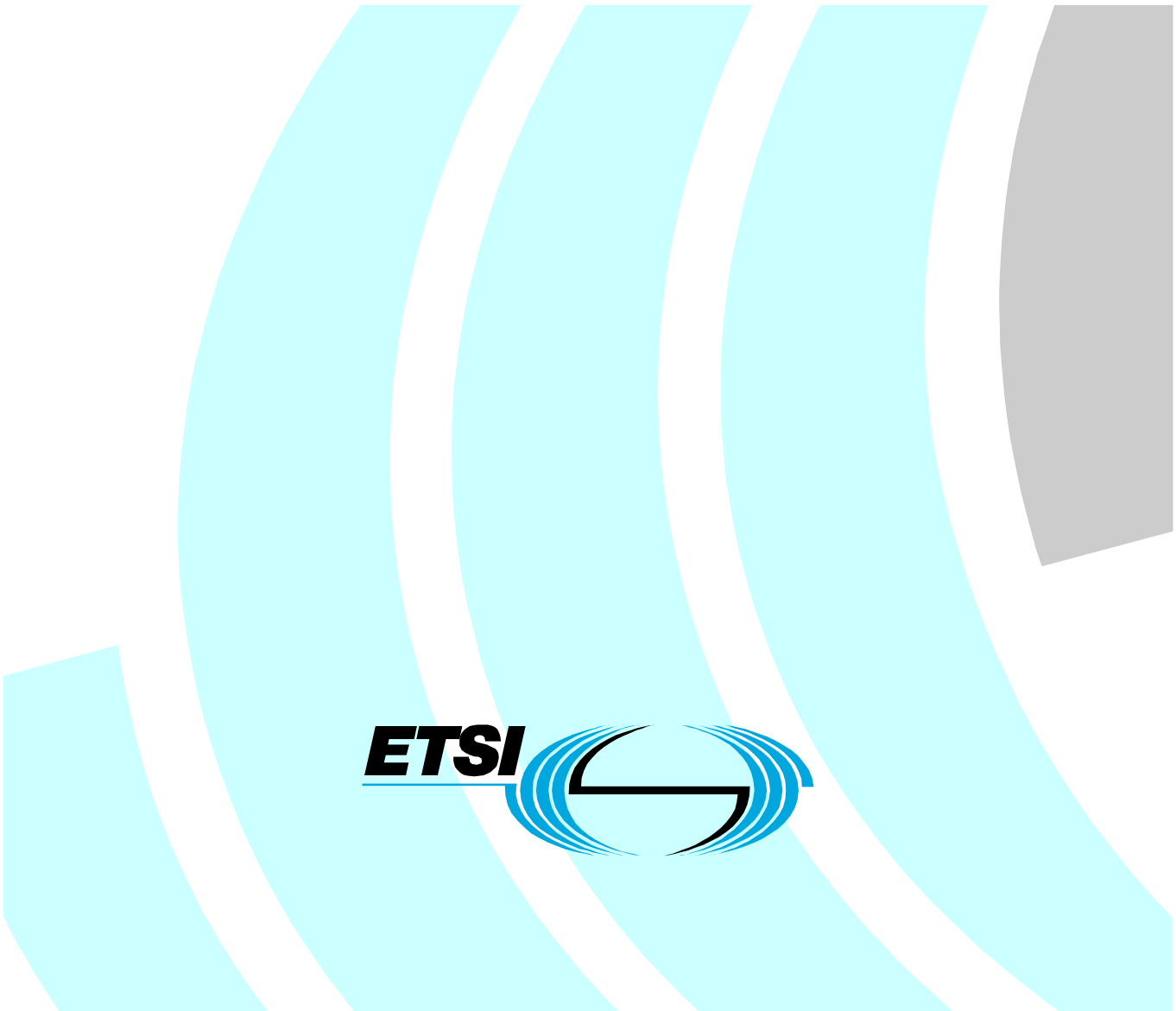
European Standard (Telecommunications series)

Electromagnetic compatibility and Radio spectrum Matters (ERM); Maritime mobile transmitters and receivers for use in the MF and HF bands; Part 1: Technical characteristics and methods of measurement



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Contents

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Foreword

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

The present document is part 1 of a multi-part deliverable covering Maritime mobile transmitters and receivers for use in the MF and HF bands, as identified below:

Part 1: "Technical characteristics and methods of measurement";

Part 2: "Harmonized EN covering essential requirements under article 3.2 of the R&TTE directive";

Part 3: "Harmonized EN covering essential requirements under article 3.3 e) of the R&TTE directive".

The present document sets out the minimum requirements for Medium Frequency (MF) and Medium and High Frequency (MF/HF) equipment on board ships, operating in the maritime mobile MF and HF radio services.

Every EN prepared by ETSI is a voluntary standard. The present document contains text concerning conformance testing of the equipment to which it relates. This text should be considered only as guidance and does not make the present document mandatory.

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

1 Scope

The present document states the minimum requirements for radio transmitters and receivers, for use on ships, operating in either the Medium Frequency (MF) only or in the Medium and High Frequency (MF/HF) bands allocated in the International Telecommunications Union (ITU) Radio Regulations [1], to the Maritime Mobile Service (MMS).

The present document includes the International Maritime Organisation (IMO) and ITU requirements included in the relevant provisions of the Radio Regulations [1], the International Convention for the Safety Of Life At Sea (SOLAS) [3], and the IMO Resolutions and A.694 (17) [4]. A806 (19) and is primarily intended to specify equipment suitable for fitting to ships subject to the SOLAS convention and complying with the European Marine Equipment Directive [19].

The present document refers to equipment for one or more of the following:

- Single SideBand (SSB) modulation for telephony transmission and reception; (J3E)
- Frequency Shift Keying (FSK) or SSB modulation of a keyed sub-carrier to transmit and receive Digital Selective Calling (DSC) signals in accordance with ITU-R Recommendation M.493-10 [5].

The present document also refers to radio equipment, which is not integrated with the DSC encoder or decoder, but defines the interfaces with such equipment.

NOTE: The requirements for integrated equipment may be found in other relevant ETSs.

The tests in the present document are applicable to receivers for operating on all frequencies in the bands 1 605 kHz to 4 000 kHz or 1 605 kHz to 27,5 MHz as allocated in the Radio Regulations [1], to the MMS.

Other spot frequency receivers should meet all the requirements of the present document and other relevant standards as applicable for the frequencies and modes provided.

If the equipment, or parts of it, are designed in such a manner that they can be used for other categories of maritime radiocommunication (e.g. Morse telegraphy or NBDP (ETS 300 067) [9]), those parts of the equipment should fulfil the relevant requirements of the appropriate standards for the service(s) in question e.g. ETS 300 067 [9].

The EMC parameters defined in the clauses of the present document covering emission tests and immunity test (see clauses 8 and 9) have been selected to ensure an adequate level of compatibility for apparatus in marine environments.

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

The present document does not address the testing of ancillary equipment on a stand-alone basis, i.e. separately from the radio equipment with which it is to be used.

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.

[1] ITU-R Recommendation (1998): "Radio Regulations" (http://www.itu.int/ITU-R/publications/rr/rr98/).

[2] ITU-T Recommendation E.161 (1988): "Arrangement of figures, letters and symbols on telephones and other devices that can be used for access to a telephone network".

[3] International Convention for the Safety of Life at Sea, (SOLAS), as amended 1988.

[4] IMO Resolutions A.806 (19) and A.694 (17).

[5] ITU-R Recommendation M.493-10 (2000): "Digital selective calling system for use in the maritime mobile service".

[6] IEC 61162-1 (2000-07): "Maritime navigation and radiocommunication equipment and systems - Digital interfaces - Part 1: Single talker and multiple listeners".

[7] ISO Standard 3791: "Office machines and data processing equipment - Keyboard layout for numeric applications".

[8] ETR 028: "Radio Equipment and Systems (RES); Uncertainties in the measurement of mobile radio equipment characteristics".

[9] ETS 300 067: "Radio Equipment and Systems (RES); Radiotelex equipment operating in the maritime MF/HF service; Technical Characteristics and methods of measurement".

[10] IEC 60050-161: "International Electrotechnical Vocabulary - Chapter 161: Electromagnetic compatibility".

[11] CISPR 16-1: "Specification for radio disturbance and immunity measuring apparatus and methods - Part 1: Radio disturbance and immunity measuring apparatus".

[12] EN 60945: "Maritime navigation and radiocommunication equipment and systems - General requirements - Methods of testing and required test results".

[13] EN 61000-4-2: "Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Clause 2: Electrostatic discharge immunity test".

[14] EN 61000-4-3: "Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Clause 3: Radiated, radio-frequency, electromagnetic field immunity test".

[15] EN 61000-4-4: "Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Clause 4: Electrical fast transient/burst immunity test".

[16] EN 61000-4-6: "Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Clause 6: Immunity to conducted disturbances, induced by radio-frequency fields".

[17] IEC 61000-4-11: "Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Clause 11: Voltage dips, short interruptions and voltage variations immunity tests".

[18] EN 61000-4-5: "Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Clause 5: Surge immunity test".

[19] Council Directive 96/98/EC of 20 December 1996 on marine equipment (the Marine Equipment Directive) (http://europa.eu.int/eur-lex/en/consleg/main/1996/en_1996L0098_index.html)

3 Definitions, symbols and abbreviations

3.1 Definitions

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

ancillary equipment: Equipment (apparatus) used in connection with a transmitter or receiver is considered to be an ancillary equipment if:

- the equipment is intended for use in conjunction with a transmitter or receiver to provide additional operational 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 the radio equipment; and

- the radio equipment to which it is connected is capable of providing some intended operation, such as transmitting or receiving, without the ancillary equipment (i.e. it is not a sub-unit of the radio equipment essential to the basic functions of the radio equipment).

assigned frequency: centre of the frequency band assigned to a station

carrier frequency: frequency to which the transmitter or receiver is tuned

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 [10]).

duplex: radiocommunications operation over a two-frequency channel with simultaneous transmission and reception

effective radiated power: product of the power supplied to the antenna and its gain relative to a half-wave dipole

NOTE: See (ITU Radio Regulations [1]).

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.

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).

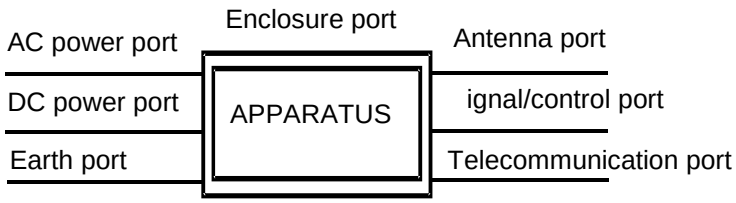


Figure 1: EUT Ports for EMC purposes

Q ratio: ratio of an observed magnitude of acceleration at the equipment to the magnitude of acceleration at the base of the vibration table

radio communications equipment: marine communications equipment which includes one or more radio transmitters or receivers or parts thereof, for use in a mobile or portable application onboard ship

NOTE: Such equipment may be operated with ancillary equipment but, if so, is not dependent upon it for basic functionality.

simplex: radiocommunications operation over a single-frequency or two-frequency channel with manual control to alternate between transmission and reception

spurious emission: emission on a frequency, or frequencies, which are outside the necessary bandwidth 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 (ITU Radio Regulations [1]).

switching range: maximum frequency range over which the receiver or the transmitter can be operated without reprogramming or realignment

transient phenomena: 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 [10]).

3.2 Symbols

For the purposes of the present document, the following symbols apply as defined in the Radio Regulations [1]:

F1B	frequency modulation, single channel containing quantized or digital information without the use of a modulating sub-carrier, telegraphy for automatic reception.
J2B	SSB, suppressed carrier, single channel containing quantized or digital information with the use of a modulating sub-carrier, telegraphy for automatic reception.
J3E	SSB, suppressed carrier, single channel containing analogue information, telephony.
dBA	relative to 2 x 10^{-5} Pa
dBd	antenna gain relative to a half-wave dipole
dBuV	dB relative to 1 microvolt emf
dBuV/m	dB relative to 1 microvolt per metre

3.3 Abbreviations

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

AC	Alternating Current
AGC	Automatic Gain Control
BER	Bit error rate
DC	Direct Current
DSC	Digital Selective Calling
DSC	Digital Selective Calling
EE	Equipment Engineering
EMC	ElectroMagnetic Compatibility
emf	electromotive force
ESD	Electrostatic Discharge
EUT	Equipment Under Test
FSI	Frequency Set Information
FSK	Frequency Shift Keying
HF	High Frequency
IEC	International Electrotechnical Committee
IF	Intermediate Frequency
IMO	International Maritime Organisation
ISO	International Standards Organisation
ITU	International Telecommunications Union
MF	Medium Frequency
MF/HF	Medium and High Frequency
MMS	Maritime Mobile Service
NBDP	Narrow Band Direct Printing telegraphy
RF	Radio Frequency
RMS	Root Mean Square
rms	root mean square
SINAD	Signal + Noise + Distortion/Noise + Distortion
SNR	Signal-to-Noise Ratio
SOLAS	Safety Of Life At Sea
SSB	Single SideBand
USB	Upper SideBand

4 General requirements

4.1 Construction

4.1.1 Design

In all respects the mechanical and electrical design and construction and the finish of the equipment shall conform with good engineering practice, and the equipment shall be suitable for use on board ships at sea.

4.1.2 Inspection and maintenance

All parts of the equipment which are subject to inspection and maintenance adjustments shall be easily accessible. Components shall be easily identifiable, either by markings within the equipment or with the aid of the technical description.

The equipment shall be so designed that the main units can be replaced readily, without elaborate re-calibration or re-adjustment.

4.1.3 Illumination

Equipment intended to be installed on the navigating bridge of a ship shall be provided with adequate illumination to enable identification of controls and facilitate reading of indicators at all times. Means shall be provided for reducing continuously, to extinction, the output of any light source on the equipment which is capable of interfering with navigation.

4.1.4 Antenna static protection

In order to provide protection against damage due to static voltages which may appear at the input of the receiver, there shall be a dc path from the antenna terminal to chassis not exceeding 100 kΩ.

4.1.5 Digital input panels

Where a digital input panel with the digits "0" to "9" is provided, the digits shall be arranged to conform with ITU-T Recommendation E.161 [2]. However, where an alphanumeric keyboard layout is provided, the digits "0" to "9" may, alternatively, be arranged to conform with ISO Standard 3791 [7].

4.1.6 Audio frequencies interfaces

The following inputs and outputs applicable to the type of equipment shall be provided:

Other interfaces may be provided but connection of, or failure within, any external circuits shall not degrade the performance of the equipment.

a) transmitters:

- SSB Telephony:
  - 600 Ω earth free audio input;
  - microphone input;
- DSC with analogue interfaces:
  - 600 Ω earth free audio input;
- DSC with digital interfaces:
  - IEC61162-1 [6] input.

The logic level and the appropriate functions shall comply with IEC61162-1 [6]. The B-state shall be logic "0", and the Y-state shall be logic "1".

b) receivers:

- SSB Telephony:
  - 600 Ω earth free audio output;
  - earphone output;
  - speaker output;
- DSC with analogue interfaces:
  - 600 Ω earth free audio output;
- DSC with digital interfaces:
  - IEC61162-1 [6] input.

  The logic level and the appropriate functions shall comply with IEC61162-1 [6]. The B-state shall be logic "0", and the Y-state shall be logic "1".

c) control(s):

The interface for control shall comply with IEC 61162-1 [6].

The protocols shall at least comply to Frequency Set Information (FSI) (see annex A).

Transmitter key input interface shall be a 2-wire circuit, closure to transmit with a maximum open circuit voltage of 50 V and a maximum closed circuit current of 100 mA.

Connectors used should be readily available commercially. Manufacturers shall provide identification of the actual connections used.

d) Voyage data recorder interface:

To facilitate the connection of separate VDR equipment, a single audio output port shall be provided, with a characteristic impedance of 600 Ω, symmetrical and free of earth, on which combined transmit and receive audio shall be present.

4.1.7 Antenna matching

The transmitter shall be fitted with an appropriate antenna matching device which shall be activated automatically, or by simple means from the control panel.

4.2 Controls and indicators

4.2.1 General

All controls shall be easily identified from the position at which the operator operates the equipment.

The number of operational controls, their design and manner of functioning, location, arrangement and size should provide for simple, quick and efficient operation. Controls which are not necessary for normal operation shall not be readily accessible to the operator.

The controls should be arranged in a manner which minimizes the risk of inadvertent operation.

For transmitters it shall be possible to change the transmitter from any class of emission to another for which it is designed to operate by means of not more than one control.

For receivers the class of emission shall be selectable by not more than one control.

4.2.2 Ease of use

It shall be possible to change the equipment from operating on any frequency provided, to operation on any other frequency provided, within a period not exceeding 15 s.

4.2.3 Loudspeaker switching

Facilities shall be provided to enable the loudspeaker to be switched off when reception is by headphones or telephone handset.

Automatic facilities shall be provided to turn off the loudspeaker during duplex operation.

4.2.4 Noise reducer

If a device is provided in the receiver to reduce the effects of impulsive noise, a switch shall be provided to disable its function.

4.2.5 Frequency indication and class of emission

Radiotelephone frequencies (J3E) shall be designated in terms of the carrier frequency which shall be indicated on the equipment.

DSC frequencies (F1B and J2B) shall be designated in terms of the assigned frequency which shall be indicated on the equipment.

Independent choice and indication of transmitting and receiving frequencies shall be possible.

For the transmitter, it should be possible to change the transmitter from any class of emission to another for which it is designed to operate by means of not more than one control.

For the receiver, the class of emission should be selectable by not more than one control.

4.2.6 Synthesizer lock

It shall not be possible to transmit until any frequency synthesizer, used to obtain the frequency set on the control panel or front of the transmitter, is locked.

4.2.7 Channel switching

It shall not be possible to transmit during transmitter channel switching operations.

Operation of the transmit/receive control shall not cause unwanted emissions.

4.2.8 Distress controls

All adjustments and controls necessary for switching the transmitter and receiver to operate on the distress and safety channels covered by the equipment shall be clearly marked in order that this operation can be easily performed.

4.2.9 Telephony transmit control

In single or two-frequency simplex operating mode, switching from the receiving condition to the transmitting condition and vice versa, shall be accomplished by a single control. This control should be located on the microphone or telephone handset and when at rest shall leave the equipment in the receive condition.

4.2.10 Misuse

The equipment shall be so designed that misuse of the controls cannot cause damage to the equipment or injury to personnel.

4.2.11 Control panel priority

If the accessible controls are located on a separate control panel and if there are two or more control panels, one of the control panels shall have priority over the others. If there are two or more control panels, when any control panel is in use, this shall be clearly indicated on all of the other control panels.

4.2.12 Manual gain control and Automatic Gain Control (AGC)

Telephony receivers shall be provided with a manual control of audio frequency gain and with an AGC of the radio frequency and/or intermediate frequency capable of operation on the classes of emission specified in clause 4.5 and the frequency ranges specified in clause 4.6.

4.2.13 Output indication

The transmitter shall incorporate an indicator of the antenna current and/or output power.

4.3 Labels

4.3.1 General

All controls, instruments, indicators and terminals shall be clearly labelled.

4.3.2 Power supplies

Details of the power supply from which the equipment is intended to operate shall be clearly indicated on the equipment.

4.3.3 Distress frequencies

The distress frequencies shown in table 1 which are applicable to the equipment, shall be clearly indicated, either on the front panel of the equipment or on an instruction label supplied with the equipment.

Table 1: Distress frequencies

DSC (kHz)	Telephony (kHz)	Telex (kHz)
2 187,5	2 182	2 174,5
4 207,5	4 125	4 177,5
6 312	6 215	6 268
8 414,5	8 291	8 376,5
12 577	12 290	12 520
16 804,5	16 420	16 695
NOTE: The above DSC and telex frequencies are assigned frequencies whereas the carrier frequency is indicated for telephony.		

In addition, manual controls necessary for the tuning of the equipment to the relevant frequencies in table 1, and their settings, shall be clearly indicated.

4.3.4 Manufacturer

All units of the equipment shall be clearly marked on the exterior with identification of the manufacturer, type designation of the equipment and serial number of the unit.

4.3.5 Compass safe distance

The compass safe distance to the standard and steering magnetic compasses shall be stated on the equipment or in the manual.

4.4 Safety precautions

4.4.1 Protection

Provision shall be made for protecting the equipment from damage if the power supply is subject to transient voltage changes, from damage due to the accidental reversal of the polarity of the power supply, and from the effects of excessive voltage.

4.4.2 Earthing

A means for earthing exposed metallic parts of the equipment shall be provided, but the equipment shall not cause any terminal of the source of electrical energy to be earthed.

4.4.3 Access

All parts and wiring in which the direct or alternating voltages or both (other than radio frequency voltages) combine to give a peak voltage greater than 50 V, shall be protected against accidental access and shall be automatically isolated from all sources of electrical energy when the protective covers are removed.

Alternatively, the equipment shall be so constructed that access to such voltages may only be gained after having used a tool for this purpose, (e.g. a spanner or screwdriver), and warning labels shall be prominently displayed both within the equipment and on protective covers.

4.4.4 Memories

The information in user programmable memory devices shall be protected from interruptions in the power supply of at least 10 h duration.

All non-user programmable memory devices shall be non-volatile.

4.5 Classes of emission

The equipment shall provide for the transmission and/or reception of signals using the classes of emission defined below, as appropriate to the equipment:

J3E	SSB telephony, with the carrier suppressed at least 40 dB below peak envelope power;
F1B	FSK suitable for DSC with a frequency shift of ±85 Hz. Alternatively class of modulation J2B can be used with a 1 700 Hz sub-carrier. In this case the equipment shall be tuned to a carrier frequency 1 700 Hz below the assigned frequency.

The receiver may also provide for the reception of signals of other classes of emission.

4.6 Frequency bands

The equipment shall be capable of operating in either the MF or in the MF/HF bands as defined in clauses 4.6.1 and 4.6.2.

4.6.1 MF band

The equipment shall provide for the transmission and/or reception in the appropriate frequency bands between 1 605 kHz and 4 000 kHz allocated in the Radio Regulations [1] to the MMS.

4.6.2 HF bands

The equipment shall provide for the transmission and/or reception in the appropriate frequency bands between 4 MHz and 27,5 MHz allocated in the Radio Regulations [1] to the MMS.

4.7 Warming up period

4.7.1 Time

The equipment shall be operational and shall meet the requirements of the present document one minute after switching on, except as provided in clause 4.7.2.

4.7.2 Heaters

If the equipment includes parts which require to be heated in order to operate correctly, (e.g. crystal ovens), then a warming-up period of 30 min from the instant of application of power to those parts shall be allowed, after which the requirements of the present document shall be met.

4.7.3 Heating circuits

Where clause 4.7.2 is applicable, the power supplies to the heating circuits shall be arranged so that they can remain operative when other supplies to the equipment or within the equipment are switched off. If a special switch for these circuits is provided on the equipment, the function of the switch shall be clearly indicated and the operating instructions shall state that the circuit should normally be left connected to the power supply source.

A visual indication that power is connected to such circuits shall be provided.

4.7.4 Delay

If it is necessary to delay the application of power to any part of the transmitter after switching on, such delay shall be provided automatically.

4.8 Instructions

Adequate and detailed operation and maintenance instructions shall be provided with the equipment.

4.8.1 Repair instructions

If the equipment is so constructed that fault diagnosis and repair is practicable down to component level, the instructions shall include full circuit diagrams, component layouts and components parts lists.

If the equipment contains modules in which fault diagnosis and repair down to component level is not practicable, the instructions shall contain sufficient information to enable localization and replacement of the defective module(s). With regard to other modules and components in the equipment, the instructions shall contain the information mentioned above.

4.8.2 Accessibility

All parts of the equipment which are subject to inspection and maintenance adjustments, shall be easily accessible. Components shall be easily identifiable either by markings within the equipment, or with the aid of a technical description.

5 Test conditions

5.1 General

Conformance testing shall be carried out under normal test conditions and, where stated, under extreme test conditions.

When preparing test report forms for equipment tested in accordance with the present document, the point where the DC voltage is measured shall be specified (see clause 5.2).

5.2 Test power source

During conformance testing the equipment shall be supplied from a test power source, capable of producing normal and extreme test voltages as specified in clauses 5.3.2 and 5.4.2.

For the purposes of tests, the voltage of the power supply shall be measured at the input terminals of the equipment.

If the equipment is provided with a power cable permanently connected, the test voltage shall be that measured at the point of connection of the power cable to the equipment.

During tests, the test power source voltages shall be maintained within a tolerance of ±3 % relative to the voltage at the beginning of each test.

5.3 Normal test conditions

5.3.1 Normal temperature and humidity

The normal temperature and humidity conditions for tests shall be any convenient combination of temperature and humidity within the following ranges:

temperature: +15°C to +35°C;

relative humidity: 20 % to 75 %.

5.3.2 Normal test power source

5.3.2.1 Mains voltage and frequency

The normal test voltage for equipment to be connected to the ac mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage or any one of the declared voltages for which the equipment was designed.

The frequency of the test power supply corresponding to the ac mains shall be 50 Hz ±1 Hz.

5.3.2.2 Secondary battery power sources

Where the equipment is designed to operate from a battery, the normal test voltage shall be the nominal voltage of the battery (e.g. 12 V, 24 V etc.).

5.3.2.3 Other power sources

For operation from other power sources, the normal test voltage shall be as stated by the manufacturer.

5.4 Extreme test conditions

5.4.1 Extreme temperature tests

When testing under extreme conditions, the measurements shall be carried out at -15°C and +55°C for equipment intended for mounting below deck, and -25°C and +55°C for equipment intended for mounting above deck.

Before making measurements, the equipment shall have reached thermal balance in the test chamber. The equipment shall be switched off during the temperature stabilizing period, except as provided in clause 4.7.3. The sequence of measurements shall be chosen, and the humidity content in the test chamber shall be controlled so that excessive condensation does not occur.

5.4.2 Extreme values of test power source

5.4.2.1 Mains voltage and mains frequency

The extreme test voltages for equipment to be connected to an ac mains supply shall be the nominal mains voltage ±10 %.

The frequency of the test power supply corresponding to the ac mains shall be 50 Hz, ±1 Hz.

5.4.2.2 Secondary battery power sources

When the equipment is intended for operation from a secondary battery power supply, the extreme test voltage shall be 1,3 and 0,9 times the nominal voltage of the battery (e.g. 12 V, 24 V etc.).

5.4.2.3 Other power sources

For equipment using other power sources, the extreme test voltages shall be as stated by the manufacturer.

5.5 Artificial antennas

5.5.1 Transmitters

For the purpose of conformance testing, the transmitter, at the output of the antenna matching device, shall meet the requirements of the present document when connected to the artificial antennas listed below:

- frequency range 1 605 to 4 000 kHz:
  - the artificial antenna shall consist of a resistance of 10 Ω and a capacitance of 250 pF connected in series;
- frequency range 4 to 27,5 MHz:
  - the artificial antenna shall consist of a resistance of 50 Ω.

These characteristics shall in no way imply that the transmitter shall only work with antennas having these characteristics.

5.5.2 Receivers

For the purpose of conformance testing, the receiver shall meet the requirements of the present document when connected to a test source, as described in clause 5.6.1.1, at the point at which the antenna is normally connected, having the following characteristics:

- the test signal shall be derived from a resistive source of 50 Ω except as permitted below;
  - in the frequency range 1 605 kHz to 4 000 kHz at the request of the manufacturer, an artificial antenna consisting of a 10 Ω resistor in series with a 250 pF capacitor may be used for frequencies below 4 MHz.

The arrangement used shall be stated in the test report.

This shall in no way imply that the receiver should operate satisfactorily only with antennas having these impedance characteristics.

5.6 Standard test signals

5.6.1 Test signals applied to the receiver input

5.6.1.1 Sources

Sources of test signals for application to the receiver input shall be connected through a network such that the impedance presented to the receiver input is equal to that of the artificial antennas specified in clause 5.5.2. This requirement shall be met irrespective of whether one, two or more test signals are applied to the receiver simultaneously. In the case of multiple test signals, steps shall be taken to prevent any undesirable effects due to interaction between the signals in the generators or other sources.

5.6.1.2 Levels

The levels of test input signals shall be expressed in terms of the emf which would exist at the output terminals of the source including the associated network referred to in clause 5.6.1.1.

5.6.2 Normal test signals

Except where otherwise stated, radio frequency test signals applied to the receiver input shall be as described in the following clauses.

5.6.2.1 Class of emission J3E

Unmodulated signal, 1 000 Hz (±0,1 Hz) above the carrier frequency to which the receiver is tuned.

5.6.2.2 Class of emission F1B

DSC with an analogue interface, unmodulated signal on the assigned frequency.

DSC with a digital interface, a signal on the assigned frequency, modulated as appropriate.

Frequency shift signal with +/- 85 Hz shift at 100 Bd with pseudo random bit pattern.

5.6.3 Choice of testing frequencies

Unless otherwise stated, tests shall be carried out at the distress frequency and one other frequency for that class of emission in each of the bands in which the equipment is designed to operate.

The frequencies used shall be stated in the test report.

5.7 Measurement uncertainty and interpretation of the measuring results.

5.7.1 Measurement uncertainty

Table 1a

Parameter	Maximum value of measurement uncertainty
RF frequency:	$\pm 1 \times 10^{-8}$
RF Power, PEP in 50 Ω	±1,5 dB
RF Power, PEP in 10 Ω/250 pF	±2,5 dB
Conducted spurious emissions of transmitter:	±4 dB
Audio output power:	±0,5 dB
Sensitivity of receiver:	±3 dB
Conducted emission of receiver:	±3 dB
Two signal measurement:	±4 dB
Three signal measurement:	±3 dB

For the test methods according to the present document the uncertainty figures are valid to a confidence level of 95 % calculated according to the methods described in ETR 028 [8].

5.7.2 Interpretation of measurement results

The interpretation of the results recorded in a test report for the measurements described in the present document shall be as follows:

- the measured value related to the corresponding limit will be used to decide whether an equipment meets the requirements of the present document;
- the measurement uncertainty value for the measurement of each parameter shall be included in the test report;
- for each measurement, the recorded value of the measurement uncertainty shall be equal to or lower than the values in clause 5.7.1.

NOTE: This procedure of using maximum acceptable uncertainty values is valid until superseded by other appropriate publications of ETSI covering this subject.

The use of the measured value has been chosen because there is no other ETSI standard covering the subject at the time of publication of this ETS. Therefore, the measurement uncertainty shall be used as a quality of the actual measurement.

The measurement uncertainty values may also be used by accreditation authorities during their accreditation procedures to ensure compliance with the requirements of type testing to ETSI standards.

6 General conditions of measurement

6.1 Sequence of testing

Testing may be carried out on either one or two samples of the product, at the manufacturer's discretion.

Where one sample is used, environmental tests shall be carried out first, before tests are performed on the same equipment with respect to the other requirements of the present document.

Where two samples (sample A and sample B) are used, environmental tests shall be carried out on sample A, while sample B shall undergo the same pre-conditioning - vibration including any endurance tests, dry heat cycle, damp heat cycle, low temperature cycle - as sample A, but without the requirement to be subjected to performance checks during the pre-conditioning.

Following environmental tests/pre-conditioning both samples shall be subject to performance checks. If either sample should fail the performance checks this shall constitute an environmental test failure.

Emissions and immunity tests shall be carried out on sample B after environmental pre-conditioning.

Tests with respect to the other requirements of the present document shall be carried out on sample A after environmental tests are completed.

6.2 Test signals and monitoring during EMC testing.

6.2.1 Test frequencies during EMC testing

The EUT shall be tuned to the frequency 2 182 kHz for MF equipment or 8 291 kHz for MF/HF equipment and operated in J3E mode.

6.2.2 Arrangements for monitoring the receiver output during EMC testing

The EUT receiver shall be connected to the measuring equipment in such a way that EUT receiver analogue speech output port operates into a resistive load which simulates the receiver's normal operating load (the value of this load shall be stated by the manufacturer).

Unless stated otherwise the EUT receiver volume control shall be set to produce 50 % of the rated audio output power.

The measuring equipment used to monitor the output signal from the EUT receiver shall be located outside the test environment.

The EUT receiver analogue speech output signal shall be coupled via an electrically non-conductive means (e.g. an acoustic tube) to the appropriate external measuring equipment. The means of connecting the receiver output signal to the measuring equipment shall be recorded in the test report.

Any user display of the EUT shall be monitored by means of a camera set up to read the information displayed. Where a manufacturer supplies additional ancillary equipment with the EUT, this equipment shall be included with the EUT inside the test environment.

Precautions shall be taken to avoid or minimize any effects upon the test due to the coupling means employed.

6.2.3 Arrangements for test signals applied to the receiver input during EMC testing

For tests in receive mode the EUT receiver shall be supplied with a wanted RF input signal as defined in clause 5.6.2.1. The level of the wanted signal shall be +22 dBuV for MF equipment or +17 dBuV for MF/HF equipment.

The signal source used to provide the EUT receiver with a wanted RF input signal shall be located outside the test environment.

The wanted RF input signal shall be delivered from the external RF signal source to the EUT antenna port by a shielded transmission line, such as a coaxial cable. Adequate measures shall be taken to minimize the effect of unwanted common mode currents on the external conductor of the transmission line at the point of entry to the EUT receiver.

6.2.4 Arrangements for test signal applied to the transmitter input during EMC testing

Unless stated otherwise, a signal generator shall be used to provide the audio frequency signal to modulate the transmitter. The signal generator shall be connected in place of the microphone transducer, and the signal shall be applied to the connection terminals normally used for the microphone transducer.

For immunity testing, the signal source used to modulate the EUT transmitter shall be located outside the test environment, (unless the transmitter is modulated by its own internal source).

6.2.5 Normal test modulation of the transmitter during EMC testing

For the purposes of the present document, normal test modulation of the EUT transmitter shall be modulation by a sinusoidal audio signal with a frequency of 1 000 Hz, to give a peak envelope power of at least 60 W.

6.2.6 Arrangements for monitoring the transmitter output during EMC testing

For transmit mode tests the EUT shall be connected to the measuring equipment in such a way that the EUT transmitter antenna port is terminated with a non-radiating non-reactive 50 Ω impedance.

The measuring equipment used to monitor the wanted RF output signal from the EUT transmitter shall be located outside the test environment.

The wanted RF output signal shall be delivered from the EUT transmitter antenna port to the external measuring equipment by a shielded transmission line, such as a coaxial cable. Adequate measures shall be taken to minimize the effect of unwanted common mode currents on the external conductor of the transmission line at the point of entry to the EUT transmitter.

Unless stated otherwise the RF output signal shall be coupled to a test suite comprising:

- a power measuring instrument;

- a demodulator and AF distortion meter.

7 Environmental tests

7.1 Introduction

The equipment shall be capable of continuous operation under the conditions of various sea states, vibration, humidity and change of temperature likely to be experienced in a ship in which it is installed.

NOTE: Classification of environmental conditions may be found in ETS 300 019-1-6.

7.2 Procedure

Environmental tests shall be carried out before tests of the same equipment in respect to the other requirements of the present document are performed.

Unless otherwise stated, the equipment shall be connected to an electrical power source during the periods for which it is specified that electrical tests shall be carried out. These tests shall be performed using the normal test voltage clause 5.3.2. and the sequence of testing shall be in the order given.

During the environmental tests, the output of the transmitter may be reduced by 6 dB, but shall exceed 60 W.

7.3 Performance check

For the purpose of the present document, the term "performance check" shall be taken to mean the following measurements and limits:

- for the transmitter:
  - frequency error:

    With the transmitter connected to an artificial antenna (see clause 5.5), the transmitter shall be tuned to the frequency 2 182 kHz for MF equipment or 8 291 kHz for MF/HF equipment and operated in J3E mode and shall be modulated with a signal of 1 000 Hz ±0,1 Hz. The 1 000 Hz signal shall be subtracted from the measured frequency to get the transmitter frequency. The transmitter frequency shall be within ±10 Hz of the selected frequency.

  - output power:

    With the transmitter connected to an artificial antenna (see clause 5.5), the transmitter shall be tuned to the frequency 2 182 kHz for MF equipment or 8 291 kHz for MF/HF equipment and operated in J3E mode. The transmitter shall be modulated by a test signal consisting of two audio frequency tones, applied simultaneously to the microphone input, at frequencies of 1 100 Hz and 1 700 Hz. The level of the tones shall be adjusted so that they produce equal output power and it shall be possible to obtain an output power of greater than 60 W PEP.

- for the receiver:
  - maximum usable sensitivity.

    With the AGC operative, the receiver shall be adjusted to 2 182 kHz for MF equipment or 8 291 kHz for MF/HF equipment and operated in J3E mode. A test signal as specified in clause 5.6.2.1 shall be applied. The level of the input signal shall be adjusted until the SINAD at the output of the receiver is 20 dB, and the output power is at least the standard output power (see clause 8.1.1). The level of the input signal shall be not greater than +22 dBµV at 2 182 kHz or not greater than +17 dBuV at 8 291 kHz.

7.4 Vibration test

7.4.1 Method of measurement

The equipment, complete with any shock absorbers which are part of it, shall be clamped to the vibration table by its normal means of support and in its normal attitude.

The equipment may be suspended to compensate for weight not capable of being withstood by the vibration table.

Provisions may be made to reduce or nullify any adverse effect on the equipment performance which may be caused by the presence of any electro-magnetic fields from the vibration table.

Taking at least 15 min to cover each octave of frequency, the equipment shall be subjected to sinusoidal vertical vibration at all frequencies between:

- 2 or 5 Hz and 13,2 Hz with an excursion of ±1 mm ±10 %;
- 13,2 Hz and 100 Hz with a constant maximum acceleration of 7 m/s/s.

A resonance search shall be carried out during the vibration test. If any resonance of the EUT has Q greater than 5 measured relative to the base of the vibration table, the EUT shall be subjected to a vibration endurance test at each resonant frequency at the vibration level specified in the test with a duration of 2 h. If no resonance with Q greater than 5 occurs the endurance test shall be carried out at one single observed frequency. If no resonance occurs the endurance test shall be carried out at a frequency of 30 Hz.

The test shall be repeated with vibration in each of the mutual perpendicular direction in the horizontal plane.

A performance check shall be carried out at least once during each endurance test period and once before the end of each endurance test period.

After conducting the vibration tests, the equipment shall be inspected for any mechanical deterioration.

7.4.2 Requirement

The limits under extreme conditions specified in clause 6.3 shall be fulfilled.

There shall be no harmful deterioration of the equipment visible to the naked eye.

7.5 Temperature tests

7.5.1 General

The maximum rate of raising or reducing the temperature of the chamber in which the equipment is being tested shall be 1°C/min.

7.5.2 Dry heat

7.5.2.1 Internally mounted equipment

7.5.2.1.1 Method of measurement

The equipment shall be placed in a chamber at normal room temperature. The temperature shall then be raised to, and maintained at, +55°C (±3°C) for a period of at least 10 h.

After this period any climatic control device provided in the equipment may be switched on.

30 min later, the equipment shall be switched on, and shall then be kept working continuously for a period of 2 h.

The equipment shall be subjected to a performance check during the 2 h period.

At the end of the test, and with the equipment still in the chamber, the chamber shall be brought to room temperature in not less than 1 h. The equipment shall then be exposed to normal room temperature and humidity for not less than 3 h before the next test is carried out.

7.5.2.1.2 Requirement

The limits under extreme conditions specified in clause 6.3 shall be fulfilled.

7.5.2.2 Externally mounted equipment

7.5.2.2.1 Method of measurement

The equipment shall be placed in a chamber at normal room temperature. The temperature shall be raised to and maintained at +70°C (±3°C) for a period of at least 10 h.

After this period any climatic control device provided in the equipment may be switched on and the chamber cooled to +55°C (±3°C). The cooling of the chamber shall be completed within 30 min.

The equipment shall then be switched on and shall be kept working continuously for a period of 2 h.

The equipment shall be subjected to a performance check during the 2 h period.

The temperature of the chamber shall be maintained at +55°C (±3°C) during the 2 h period.

At the end of the test, and with the equipment still in the chamber, the chamber shall be brought to room temperature in not less than 1 h. The equipment shall then be exposed to normal room temperature and humidity for not less than 3 h before the next test is carried out.

7.5.2.2.2 Requirement

The limits under extreme conditions specified in clause 6.3 shall be fulfilled.

7.5.3 Damp heat

7.5.3.1 Method of measurement

The equipment shall be placed in a chamber at normal room temperature and humidity which, steadily, over a period of 3 h (±0,5 h), shall be heated from room temperature to +40°C (±3°C) and shall during this period be brought to a relative humidity of 93 % (±2 %) so that excessive condensation is avoided.

These conditions shall be maintained for a period of at least 10 h.

After this period, any climatic control devices provided within the equipment may be switched on.

30 min later the equipment shall be switched on, and shall then be kept working continuously for a period of 2 h.

The equipment shall be subjected to a performance check during the 2 h period.

The temperature and the relative humidity of the chamber shall be maintained at +40°C (±3°C) and 93 % (±2 %) during the 2 h 30 min period.

At the end of the test, and with the equipment still in the chamber, the chamber shall be brought to room temperature in not less than 1 h. The equipment shall then be exposed to normal room temperature and humidity for not less than 3 h, or until moisture has dispersed, which ever is longer, before the next test is carried out.

7.5.3.2 Requirement

The limits under extreme conditions specified in clause 6.3 shall be fulfilled.

7.5.4 Low temperature cycle

7.5.4.1 Internally mounted equipment

7.5.4.1.1 Method of measurement

The equipment shall be placed in a chamber at normal room temperature. The temperature shall then be reduced to, and maintained at, -15°C (±3°C) for a period of at least 10 h.

After this period, any climatic control devices and/or heat sources provided in the equipment may be switched on.

The equipment shall then be subjected to a performance check lasting no more than 30 min.

The temperature of the chamber shall be maintained at -15°C (±3°C) during the performance check.

At the end of the test, and with the equipment still in the chamber, the chamber shall be brought to room temperature in not less than 1 h. The equipment shall then be exposed to normal room temperature for not less than 3 h, or until moisture has dispersed, which ever is longer, before the next test is carried out.

7.5.4.1.2 Requirement

The limits under extreme conditions specified in clause 6.3 shall be fulfilled.

7.5.4.2 Externally mounted equipment

7.5.4.2.1 Method of measurement

The equipment shall be placed in a chamber at normal room temperature. The temperature shall then be reduced to, and maintained at, -30°C (±3°C) for a period of at least 10 h.

Any climatic control devices provided in the equipment may then be switched on and the chamber warmed to -20°C (±3°C). The warming of the chamber shall be completed within 30 min (±5 min).

The temperature of the chamber shall then be maintained at -20°C (±3°C) during a period of 1 h 30 min.

The equipment shall be subjected to a performance check during the last 30 min of the test. Any heat sources for the equipment may be switched on during the performance check.

At the end of the test, and with the equipment still in the chamber, the chamber shall be brought to room temperature in not less than 1 h. The temperature shall then be exposed to normal room temperature for not less than 3 h, or until moisture has dispersed, which ever is longer, before the next test is carried out.

Throughout the test the equipment shall be working normally.

7.5.4.2.2 Requirement

The limits under extreme conditions specified in clause 6.3 shall be fulfilled.

7.6 Corrosion test

7.6.1 General

This test may be excluded if sufficient evidence is provided that the corresponding requirements of this clause are met.

7.6.2 Method of measurement

The equipment shall be placed in a chamber fitted with apparatus capable of spraying in the form of a fine mist a salt solution to the following formula:

- sodium chloride 26,50 grammes ±10 %;
- magnesium chloride 2,50 grammes ±10 %;
- magnesium sulphate 3,50 grammes ±10 %;
- calcium chloride 1,10 grammes ±10 %;
- potassium chloride 0,73 grammes ±10 %;
- sodium bicarbonate 0,20 grammes ±10 %;
- sodium bromide 0,28 grammes ±10 %;
- plus distilled water to make the solution up to 1 litre.

Alternatively a 5 % sodium chloride (NaCl) solution may be used.

The salt used for the test shall be high quality sodium chloride (NaCl) containing, when dry, not more than 0,1 % sodium iodide and not more than 0,3 % of total impurities.

Salt solution concentration shall be 5 % (±1 %) by weight.

The solution shall be prepared by dissolving, by weight, 5 parts ±1 part of salt in 95 parts of distilled or de-mineralized water.

The pH value of the solution shall be between 6,5 and 7,2 at temperature of 20°C (±2°C). The pH value shall be maintained within this range during conditioning; for this purpose, diluted hydrochloric acid or sodium hydroxide may be used to adjust the pH value, provided that the concentration of NaCl remains within the prescribed limits. The pH value shall be measured when preparing each new batch of solution.

The spraying apparatus shall be such that the products of corrosion cannot mix with the salt solution contained within the spray reservoir.

The equipment shall be sprayed simultaneously on all its external surfaces with the salt solution for a period of 1 h.

This spraying shall be carried out four times with a storage period of 7 days at 40°C (±2°C) after each spraying. The relative humidity during storage shall be maintained between 90 % and 95 %.

At the end of the total period the equipment shall be examined visually.

The equipment shall then be subjected to a performance check.

7.6.3 Requirements

There shall be no undue deterioration or corrosion of the metal parts, finishes, material or component parts visible to the naked eye.

In the case of hermetically sealed equipment there shall be no evidence of moisture penetration.

The limits under normal conditions specified in clause 6.3 shall be fulfilled.

7.7 Rain test

7.7.1 General

The test shall only be performed for equipment to be mounted above deck.

7.7.2 Method of measurement

The equipment shall be placed in an appropriate measurement chamber.

Throughout the test the equipment shall be working normally.

The test shall be carried out by spraying the equipment from all practicable directions with a stream of water from a hose.

The conditions to be observed are as follows:

- internal diameter of the nozzle: 12,5 mm;
- delivery rate: 100 l/min (±5 %);
- water pressure at the nozzle: approximately 100 kPa (1 bar). The pressure shall be adjusted to achieve the specified delivery rate. At 100 kPa the water shall rise freely for a vertical distance of approximately 8 metres above the nozzle;
- test duration: 30 min;
- distance from the nozzle to the equipment surface: approximately 3 metres.

At the end of the test the equipment shall be subjected to a performance check and inspected.

Following inspection, the equipment shall be resealed in accordance with the manufacturer's instructions.

7.7.3 Requirements

The limits under normal conditions specified in clause 6.3 shall be fulfilled.

There shall be no evidence of ingress of water visible to the naked eye.

8 Emissions tests

8.1 General conditions for emissions tests

The individual tests called up in the following clauses shall be performed in accordance with the EMC standards referred to in each case.

Tests shall be carried out under normal test conditions, i.e. using the normal power source voltage as defined in clause 5.3.2 and under conditions of normal temperature and humidity as defined in clause 5.3.1

Measurements shall be performed both with the EUT in receive mode and with the EUT in transmit mode using normal test modulation.

The test configuration and mode of operation of the EUT shall be as close as possible to the normal intended use, and shall be recorded in the test report.

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

If the EUT is part of a system, or can be connected to ancillary equipment, then it shall be configured with at least the minimum necessary set of ancillary equipment to fully exercise the EUT ports.

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

EUT ports which are connected in normal operation shall be connected, either to ancillary equipment or to a representative length of cable terminated to simulate the impedance of the ancillary equipment.

EUT ports which are not normally connected, e.g. service connectors, shall not be connected to any cables for the purpose of emissions testing.

All RF ports shall be correctly terminated.

Where it is necessary to deviate from a normal and representative test configuration, e.g. in terms of port connections or cable lengths, in order to fully exercise the EUT, then due precautions shall be taken to ensure that the evaluation of the EUT is not affected.

8.2 Conducted emissions from power ports

8.2.1 Definition

This test assesses the ability of the EUT to limit the coupling of its internal noise to the AC or DC power port.

8.2.2 Test method

The test method shall be in accordance with EN 60945 [12]

The power port of the EUT shall be connected to an Artificial Mains Network complying with CISPR 16-1 [11] by means of a screened cable which shall not exceed 0,8 m in length.

If the EUT consists of more than one unit with individual AC and/or DC power ports, power ports of the same nominal supply voltage shall be connected in parallel to the Artificial Mains Network.

The setting of controls which may affect the level of conducted interference shall be varied in order to ascertain the maximum emission level.

The RF voltage appearing across the defined impedance provided by the Artificial Mains Network connected to the power supply terminals of the EUT, in the frequency range from 10 kHz to 30 MHz, shall be measured by means of a quasi-peak measuring receiver complying with CISPR 16-1 [11]. The measuring bandwidth shall be:

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

For measurements with the EUT in transmit mode, there shall be an exclusion band of 200kHz centred at the fundamental and any harmonics within the measurement band.

8.2.3 Limits

The level of any conducted spurious signal shall not exceed the values given in Figure 2.

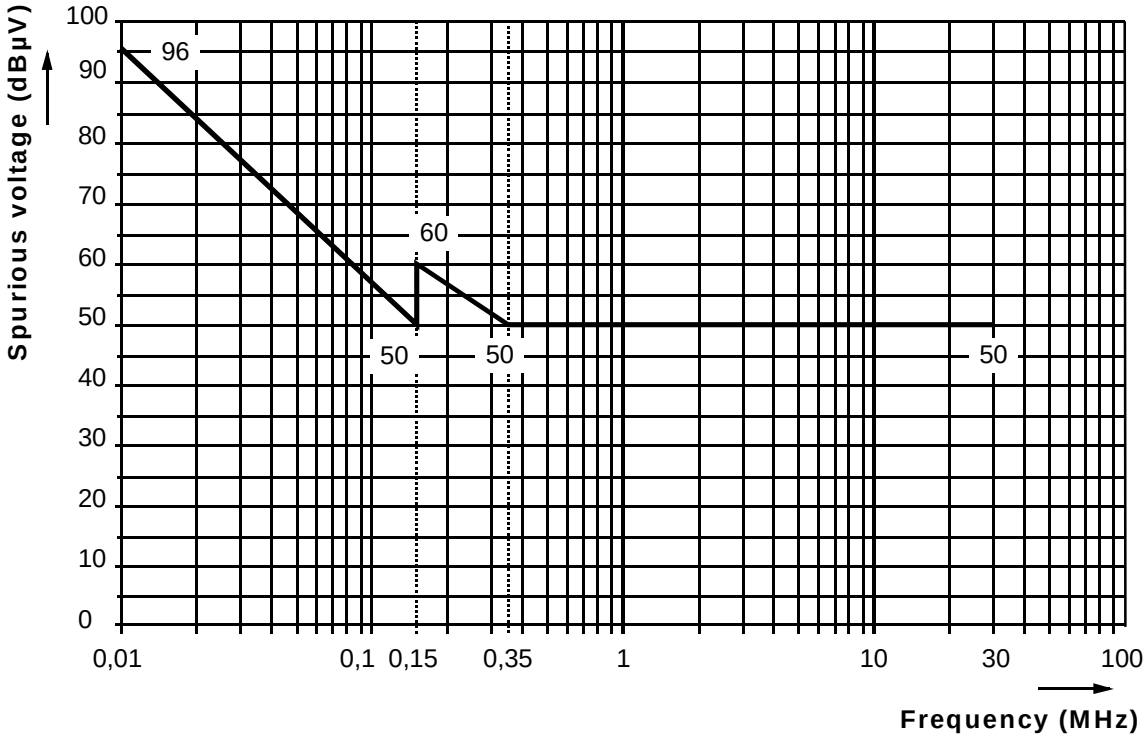


Figure 2: Maximum permissible level (quasi-peak) of conducted emissions into the mains

8.3 Radiated emissions from the enclosure port

8.3.1 Definition

This test assesses the ability of the EUT to limit the radiation of its internal noise from the enclosure port.

8.3.2 Method of test

a) The quasi-peak measuring receivers specified in CISPR 16-1 [11] shall be used. The receiver bandwidth in the frequency ranges 30 MHz to 2 GHz shall be 120 kHz.

Measurements shall be made of the electric E field. The measuring antenna shall be a balanced dipole of resonant length, or alternate shortened dipole or higher gain antenna as described in CISPR 16-1 [11]. The dimensions of the measuring antenna in the direction of the EUT shall not exceed 20 % of its distance from the EUT. At frequencies above 80 MHz it shall be possible to vary the height of the centre of the measuring antenna above the ground over a range of 1 m to 4 m. The test site shall be compliant with CISPR 16-1 [11], using a metal ground plane and of dimensions to allow a measurement distance of 3 m.

The EUT shall be fully assembled, complete with its associated interconnecting cables and mounted in its normal plane of operation.

When the EUT consists of more than one unit, the interconnecting cables (other than microwave) between the main unit and all other units shall be the maximum length as specified by the manufacturer or 20 m whichever is shorter. Available input and output ports shall be connected to the maximum length of cable as specified by the manufacturer or 20 m whichever is shorter, and terminated to simulate the impedance of the ancillary equipment to which they are normally connected.

The excess length of these cables shall be bundled at the approximate centre of the cable with bundles of 30cm to 40cm in length running in the horizontal plane from the port to which they are connected. If it is impractical to do so because of cable bulk or stiffness, the disposition of the excess cable shall be as close as possible to that required and shall be precisely described in the test report.

The test antenna shall be placed at a distance of 3 m from the EUT. The centre of the antenna shall be at least 1,5 m above the ground plane. The E field antenna only shall be adjusted in height and rotated to give horizontal and vertical polarization, one being parallel to the ground, in order to determine the maximum emission level. Finally the antenna shall either moved around the EUT, again in order to determine the maximum emission level, or alternatively the EUT may be placed on a plane orthogonal to the test antenna at its mid-point and rotated to achieve the same effect.

In addition, for the frequency band 156 MHz to 165 MHz, the measurement shall be repeated with a receiver bandwidth of 9 kHz, all other conditions of a) here above remaining unchanged.

Alternatively, for the frequency band 156 MHz to 165 MHz, a peak receiver or a spectrum analyser may be used.

8.3.3 Limits

Within the frequency band 30 MHz to 156 MHz the radiated emissions shall not exceed a level of 54 dBuV/m (quasi peak).

Within the frequency band 156 MHz to 165 MHz the radiated emissions shall not exceed a level of 24 dBuV/m (quasi peak) or a level of 30 dBuV/m (peak).

Within the frequency band 165 MHz to 2 GHz the radiated emissions shall not exceed a level of 54 dBuV/m (quasi peak).

9 Immunity tests

9.1 General conditions for immunity tests

9.1.1 Introduction

Tests shall be carried out under normal test conditions, i.e. using the normal power source voltage as defined in clause 5.3.2 and under conditions of normal temperature and humidity as defined in clause 5.3.1.

Measurements shall be performed both with the EUT in receive mode and with the EUT in transmit mode. The individual tests called up in the following clauses shall be performed in accordance with the EMC standards referred to in each case.

9.1.2 Performance assessment

To enable the performance of the equipment to be assessed the manufacturer must supply the following information to be recorded in the test report:

- a listing of the user control functions and stored data required for normal operation of the EUT, and details of the method to be used to assess whether these have been lost after an immunity test;
- an exhaustive list of ports, classified as either power, signal/control or antenna ports, with associated maximum cable lengths; power ports shall further be classified as AC or DC power;

- the 6 dB bandwidth of the IF filter immediately preceding the demodulator;
- any ancillary equipment to be combined with the radio equipment for testing, where applicable;
- details of any test equipment delivered to enable the assessment of the EUT;
- details of the frequency bands over which the equipment is intended to operate.

9.1.3 Ancillary equipment

Assessment of ancillary equipment separately from the EUT with which it is associated is outside the scope of the present document.

For ancillary equipment tested in conjunction with the EUT, the behaviour of the EUT shall be used to determine compliance.

At the manufacturer's discretion ancillary equipment may be tested and assessed separately against the requirements of EN 60945 [12], in which case compliance may enable the ancillary equipment to be used with other appropriate equipment.

9.1.4 Test configuration

The test configuration and mode of operation of the EUT shall be as close as possible to the normal intended use, and shall be recorded in the test report.

If the EUT is part of a system, or can be connected to ancillary equipment, then it shall be configured with at least the minimum necessary set of ancillary equipment to fully exercise the EUT ports.

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

EUT Ports which are connected in normal operation shall be connected, either to ancillary equipment or to a representative length of cable terminated to simulate the impedance of the ancillary equipment.

All RF ports shall be correctly terminated.

EUT Ports which are not normally connected, e.g. service connectors, shall not be connected to any cables for the purposes of immunity testing.

Where it is necessary to deviate from a normal and representative test configuration, e.g. in terms of port connections or cable lengths, in order to fully exercise the EUT, then due precautions shall be taken to ensure that the evaluation of the EUT is not affected.

9.1.5 Exclusion bands

9.1.5.1 Definition

During immunity tests with continuous phenomena (conducted and radiated RF immunity tests), the EUT shall not be subjected to the RF disturbance signal within the frequency band defined as the receiver exclusion band in the case of receive mode tests, or the frequency band defined as the transmitter exclusion band in the case of transmit mode tests.

9.1.5.2 Transmitter exclusion band for immunity tests

For the purposes of immunity testing the transmitter exclusion band is defined as a 100 kHz segment of the spectrum centred at the nominal carrier frequency of the transmitter.

9.1.5.3 Receiver exclusion band for immunity tests

For the purposes of immunity testing the receiver exclusion band is defined as the operating frequency band of the receiver, as declared by the manufacturer, extended at each end by 5 % of the end-of-band frequency.

9.1.6 Assessment of receiver responses

Responses of receivers which are narrow-band responses (spurious responses) at discrete frequencies, occurring during immunity tests for continuous phenomena, shall be identified by the following method:

If during an immunity test the presence of the test RF electromagnetic disturbance (the interfering signal) causes a degradation of the performance of the receiver such that it fails the performance check, it is necessary to establish whether this is due to a narrow-band response or to a wideband phenomenon. Therefore, the frequency of the interfering signal is increased by an amount equal to twice the nominal 6 dB bandwidth of the EUT receiver IF filter immediately preceding the demodulator of the receiver, as declared by the manufacturer. The test is repeated with the frequency of the interfering signal decreased by the same amount.

If the degradation of the receiver performance disappears when the interfering signal is offset in this way, then the response is considered to be a narrow-band response. If the degradation remains this may be due to the fact that the offset has made the frequency of the interfering signal correspond to the frequency of another narrow-band response. Under these circumstances the procedure is repeated with the offset of frequency of the interfering signal increased to two and a half times that used above.

If the degradation of the receiver performance still remains, then the response is considered to be a wideband phenomena and therefore an EMC immunity problem, and the equipment fails the test.

Narrow-band responses are dealt with fully in clause 11.10, and shall be disregarded during immunity testing.

9.2 Performance criteria

9.2.1 Categories

One of the following three categories of performance criteria is applicable to determine whether the EUT meets the requirements of each immunity test:

- performance criteria A for continuous phenomena;
- performance criteria B for transient phenomena;
- performance criteria C for power supply failure.

9.2.2 Performance criteria A for continuous phenomena

The following general performance criteria shall apply in the case of continuous phenomena.

The EUT shall be subjected to the immunity performance check during and after the test.

During the test sequence the EUT shall not transmit unintentionally.

During and after the test, the EUT shall continue to operate as intended. No degradation of performance or loss of function is allowed below the level defined by the immunity performance check and the technical specification published by the manufacturer.

No change to the selected mode of operation of the EUT or to its stored data shall occur as a result of the test.

9.2.3 Performance criteria B for transient phenomena

The following general performance criteria shall apply in the case of transient phenomena.

The EUT shall be subjected to the immunity performance check after the test.

During the test sequence the EUT shall not transmit unintentionally, however some degradation of performance is permissible.

After the test, the EUT shall continue to operate as intended. No degradation of performance or loss of function is allowed below the level defined by the immunity performance check and the technical specification published by the manufacturer.

No change to the selected mode of operation of the EUT or to its stored data shall occur as a result of the test.

9.2.4 Performance criteria C for power supply failure

The following general performance criteria shall apply in the case of power supply failure.

The EUT shall be subjected to the immunity performance check after the test.

During the test sequence the EUT shall not transmit unintentionally.

Temporary loss of function will occur during the test sequence.

After the test, normal function and performance of the EUT, as defined by the immunity performance check and the technical specification published by the manufacturer, shall be either self-recoverable or able to be restored by operation of user controls.

No change to the EUT stored data shall occur as a result of the test.

9.2.5 Immunity performance check

An immunity performance check shall be a performance check as defined in clause 7.3, with the additional requirements detailed in clause 9 in respect of test conditions, EUT configuration, and the interconnection of the EUT and the test equipment fully observed.

The immunity performance check is used in conjunction with the appropriate performance criteria to determine whether the EUT meets the requirements of an immunity test.

9.3 Electrostatic discharge immunity (ESD)

9.3.1 Definition

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 [13]

The test generator, test set-up and test procedure shall be in accordance with EN 61000-4-2 [13]. The test levels shall be 6 kV contact discharge and 8 kV air discharge. All other details, including intermediate test levels, are contained in EN 61000-4-2 [13].

The test shall be performed with ten single discharges applied to each test point. Ten test points shall be chosen on exposed surfaces on any unit of the EUT including, where appropriate, knobs and other protrusions or projecting parts accessible to the user in normal operation.

Care shall be taken not to apply these discharges to the conductive pins of connectors.

9.3.3 Performance criteria

Performance criteria B for transient phenomena, clause 9.2.3, shall apply.

During the test sequence the EUT shall be monitored for unintentional transmissions.

After the test the EUT shall be checked for continuity of the selected mode of operation and stored data, subjected to the immunity performance check, and checked for normal function against the manufacturers technical specification.

9.4 RF electromagnetic fields in the frequency range 80 MHz to 2 GHz

9.4.1 Definition

This test assesses the ability of the EUT to operate as intended in the presence of an RF electromagnetic disturbance impinging upon the enclosure.

9.4.2 Test method

The test method shall be in accordance with EN 61000-4-3 [14].

The following requirements and evaluation of test results shall apply:

- the test level of the field disturbance signal shall be 10 V/m (measured unmodulated); the test signal shall be amplitude modulated to a depth of 80 % by a sinusoidal audio signal of 400 Hz;
- the test shall be performed over the frequency range 80 MHz to 2 GHz with the exception of the transmitter exclusion band, clause 9.1.5.2, or of the receiver exclusion band, clause 9.1.5.3, as appropriate;
- stepped increments of the field disturbance signal frequency shall be increments of 1 % of the momentary used frequency;
- EUT receiver responses occurring at discrete frequencies which are narrow-band responses, clause 9.1.6, shall be disregarded;
- the frequencies of the field disturbance signal selected and used during the test shall be recorded in the test report.

9.4.3 Performance criteria

Performance criteria A for continuous phenomena, clause 9.2.2, shall apply.

During the test sequence the EUT shall be monitored for unintentional transmissions.

During and after the test the EUT shall be checked for continuity of the selected mode of operation and stored data, subjected to the immunity performance check, and checked for normal function against the manufacturers technical specification.

9.5 Fast transient, common mode

9.5.1 Definition

This test assesses the ability of the EUT to operate as intended in the event of fast transients or bursts present on power, signal or control ports.

9.5.2 Test method

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

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

All ports which were not tested because the manufacturer declared them not intended for use with cables longer than 3 m shall be listed in the test report.

The test method shall be in accordance with EN 61000-4-4 [15].

A test generator complying with clause 6.1.1 of EN 61000-4-4 [15] shall be used. The induction of the interference shall be:

- to AC/DC power ports by a coupling/decoupling network complying with clause 6.2 of EN 61000-4-4 [15];
- to signal and control ports by a capacitive coupling clamp complying with clause 6.6.3 of EN 61000-4-4 [15].

The test level shall be 2 kV. The test voltage shall be applied as a 15 ms burst every 300 ms for a duration of 3 min each for both positive and negative polarity of the test voltage.

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

9.5.3 Performance criteria

Performance criteria B for transient phenomena, clause 9.2.3, shall apply.

During the test sequence the EUT shall be monitored for unintentional transmissions.

After the test the EUT shall be checked for continuity of the selected mode of operation and stored data, subjected to the immunity performance check, and checked for normal function against the manufacturers technical specification.

9.6 Conducted disturbances on power ports (RF common mode)

9.6.1 Definition

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

9.6.2 Test method

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

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

All ports which were not tested because the manufacturer declared them not intended for use with cables longer than 3 m shall be listed in the test report.

The test method shall be in accordance with EN 61000-4-6 [16].

The following requirements and evaluation of test results shall apply:

- the disturbance signal shall be applied to the power supply line by a coupling/decoupling network complying with clause 6.2.2.1 of EN 61000-4-6 [16];
- the disturbance signal shall be applied to signal input/output and control lines by direct injection as described in clause 6.2.1 of EN 61000-4-6 [16];
- the test level shall be severity level 2 as given in EN 61000-4-6 [16], corresponding to 3 V rms unmodulated; the test signal shall be amplitude modulated 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 the transmitter exclusion band, clause 9.1.5.2, or of the receiver exclusion band, clause 9.1.5.3, as appropriate;
- for receivers the stepped increments of the disturbance signal frequency shall be increments of 50 kHz in the frequency range 150 kHz to 5 MHz and increments of 1 % of the momentary frequency in the frequency range 5 MHz to 80 MHz;

- for transmitters the stepped increments of the disturbance signal frequency shall be increments of 500 kHz in the frequency range 150 kHz to 5 MHz and increments of 10 % of the momentary frequency in the frequency range 5 MHz to 80 MHz;
- additionally a test shall be performed with a test level of 10 V rms at the following frequencies:
  - 2 MHz
  - 3 MHz
  - 4 MHz
  - 6,2 MHz
  - 8,2 MHz
  - 12,2 MHz
  - 16,5 MHz
  - 18,8 MHz
  - 22 MHz
  - 25 MHz;
- EUT receiver responses occurring at discrete frequencies which are narrow-band responses, clause 11.10, shall be disregarded;
- the frequencies of the disturbance signal selected and used during the test shall be recorded in the test report.

9.6.3 Performance criteria

Performance criteria A for continuous phenomena, clause 9.2.2, shall apply.

During the test sequence the EUT shall be monitored for unintentional transmissions.

During and after the test the EUT shall be checked for continuity of the selected mode of operation and stored data, subjected to the immunity performance check, and checked for normal function against the manufacturers technical specification.

9.7 Power supply short term variations

9.7.1 Definition

This test assesses 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.

9.7.2 Test method

This test shall be performed on the AC power port of the EUT and associated ancillary equipment.

The test method shall be in accordance with EN 60945 [12]. The EUT shall be subject to the following power supply variations relative to the nominal value once per minute for the duration of 10 min each:

supply voltage = nominal supply voltage + (20 ±1) %,
duration 1,5 s ±0,2 s;
supply frequency = nominal supply frequency + (10 ±0,5) %,
duration 5 s ±0,5 s;
superimposed;

supply voltage = nominal supply voltage – (20 ±1) %,
duration 1,5 s ±0,2 s;
supply frequency = nominal supply frequency – (10 ±0,5) %,
duration 5 s ±0,5 s;
superimposed.

The voltage and frequency variation rise and decay times are 0,2 s ±0,1 s (from 10 % to 90 %).

All other details are contained in IEC 61000-4-11 [17].

9.7.3 Performance criteria

Performance criteria B for transient phenomena, clause 9.2.3, shall apply.

During the test sequence the EUT shall be monitored for unintentional transmissions.

After the test the EUT shall be checked for continuity of the selected mode of operation and stored data, subjected to the immunity performance check, and checked for normal function against the manufacturers technical specification.

9.8 Power supply failure

9.8.1 Definition

This test assesses the ability of the EUT to operate as intended after being subjected to interruptions in the power supply.

9.8.2 Test method

The EUT shall be subjected to three breaks in the power supply each of 60 s duration as defined in EN 61000-4-11 [17].

9.8.3 Performance criteria

Performance criterion C, clause 9.2.4, shall apply.

During the test sequence the EUT shall be monitored for unintentional transmissions.

After the test the EUT may be restored to normal function by operation of user controls if necessary. The EUT shall be checked for continuity of stored data, subjected to the immunity performance check, and checked for normal function against the manufacturers technical specification.

9.9 Surge

9.9.1 Definition

These tests assess the ability of the EUT to operate as intended in the event of surges on the AC power input ports.

9.9.2 Test method

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

The test method shall be in accordance with EN 61000-4-5 [18]

A combination wave (hybrid) generator complying with clause 6.1 of EN 61000-4-5 [18] in combination with a coupling/decoupling network complying with clause 6.3 of EN 61000-4-5 [18] shall be used.

The following requirements and evaluation of test results shall apply:

- the test voltage shall be 0,5 kV line-to-line and 1 kV line-to-ground with the output impedance of the surge generator as given in the EN 61000-4-5 [18]; the test voltage shall be applied with a repetition rate of 1 pulses per minute for a duration of 5 min each for both positive and negative polarity of the test voltage;
- the test generator shall provide the 1,2/50 µs pulse as defined in EN 61000-4-5 [18].

9.9.3 Performance criteria

Performance criteria B for transient phenomena, clause 9.2.3, shall apply.

During the test sequence the EUT shall be monitored for unintentional transmissions.

After the test the EUT shall be checked for continuity of the selected mode of operation and stored data, subjected to the immunity performance check, and checked for normal function against the manufacturers technical specification.

10 Transmitter

10.1 General

10.1.1 Output power reduction

The output power shall be set automatically by the equipment according to frequency band and mode of operation as declared by the manufacturer.

If the transmitter is capable of a higher output power than 400 W, means shall be provided to limit the power to a value of 400 W or less and when the transmitter is switched to the MF band this power reduction shall be automatic.

10.1.2 Class of emission

The transmitter shall provide USB only, or USB and FSK signals in accordance with clause 4.5.

10.1.3 Minimum number of operating frequencies

10.1.3.1 Transmitters operating between 1 605 and 4 000 kHz only

The transmitter shall have facilities for operation on all frequencies in the bands allocated in the Radio Regulations [1], to the MMS.

10.1.3.2 Transmitters operating between 1 605 and 27 500 kHz

The transmitter shall have facilities for operation on all frequencies in the bands allocated in the Radio Regulations [1], to the MMS.

10.2 Frequency error

10.2.1 Definition

The frequency error of the transmitter is defined as:

a) for SSB telephony:

- the difference between the measured frequency less 1 000 Hz and the nominal value of the frequency for the particular telephony channel.

b) for DSC with an analogue interface:

- the difference between the measured and the nominal assigned frequency.

c) for DSC with a digital interface:

- the difference between the measured Y-state frequency and the nominal assigned frequency -85 Hz and the difference between the measured B-state frequency and the nominal assigned frequency +85 Hz.

10.2.2 Method of measurement

The frequency shall be measured with the transmitter connected to an artificial antenna (see clause 5.5).

Measurement shall be made under normal test conditions (see clause 5.3) and under extreme test conditions (clauses 5.4.1 and 5.4.2 applied simultaneously).

a) SSB telephony:

- the transmitter shall be modulated with a signal of 1 000 Hz ±0,1 Hz. The 1 000 Hz signal shall be subtracted from the measured frequency to get the transmitter frequency.

b) DSC with an analogue interface:

- the transmitter shall be modulated with a signal of 1 700 Hz ±0,1 Hz.

c) DSC with a digital interface:

- the digital input shall first be connected to a digital 0 and then to a digital 1.

10.2.3 Limits

The transmitter frequencies shall, after the warming-up period specified in clause 4.7 be within ±10 Hz of the frequencies calculated in accordance with the definitions in clause 10.2.1.

10.3 Output power and intermodulation products

10.3.1 Definitions

The output power is the value of peak envelope power delivered by the transmitter to the artificial antenna in telephony SSB mode or the value of the mean power delivered by the transmitter to the artificial antenna in DSC mode.

The measurement of intermodulation products characterizes the linearity of amplitude modulated transmitters and is defined in ITU-R Recommendation 326-6 (see bibliography).

10.3.2 Method of measurement

The transmitter shall be connected to the appropriate artificial antenna as specified in clause 5.5.1.

a) For SSB telephony:

- the transmitter shall be modulated by a test signal consisting of two audio frequency tones, applied simultaneously to the microphone input, at frequencies of 1 100 Hz and 1 700 Hz. The level of the tones shall be adjusted so that they produce equal output power. The level of the input test signal shall be increased until the transmitter power output is the rated output power as declared by the manufacturer ±1,5 dB. The level of the input signal shall then be increased by 10 dB;

- the peak envelope power and the intermodulation products shall be measured;

- the input signal shall then be decreased by 20 dB, and measurement of the intermodulation products is repeated;

- the test shall be repeated using the 600 Ω audio line input connections provided.

b) For DSC with an analogue interface:

- the transmitter shall be modulated by a generator producing a continuous dot pattern first at 0 dBm at 600 Ω and then at +10 dBm at 600 Ω. The mean power and the difference between the power of the Y-state frequency and the power of the B-state frequency shall be measured, and the output spectrum recorded.

c) For DSC with a digital interface:

- the transmitter shall be modulated by a generator producing a continuous dot pattern. The mean power and the difference between the power of the Y-state frequency and the power of the B-state frequency shall be measured, and the output spectrum recorded.

The tests shall be performed under both normal (clause 5.3) and extreme test conditions (clauses 5.4.1 and 5.4.2 applied simultaneously).

10.3.3 Limits

10.3.3.1 Output power in the range 1 605 to 4 000 kHz for all modulation modes

At 2 182 kHz the maximum peak envelope power or maximum mean power, as appropriate (see clause 10.3.1), shall be within ±1,5 dB of the manufacturer's declared value(s), shall be greater than 60 W and shall not exceed 400 W.

10.3.3.2 Output power in the range 4 to 27,5 MHz for all modulation modes

On each of the distress frequencies in bands 4, 6, 8, 12, 16 MHz and on one frequency in the highest band of operation, the maximum peak envelope power or maximum mean power, as appropriate (see clause 10.3.1), shall be within ±1,5 dB of the manufacturer's declared value(s), shall be greater than 60 W, and shall not exceed 1 500 W.

10.3.3.3 Intermodulation products for SSB telephony modes

The value of intermodulation products shall not exceed 25 dB below the highest of the two tones under normal test conditions and shall not exceed 22 dB below the highest of the two tones under extreme test conditions.

10.3.3.4 Difference of power of B-state frequency and Y-state frequency

The difference of the power of the B-state frequency and the Y-state frequency shall not exceed 2 dB.

10.3.3.5 Output spectrum

The output spectrum on DSC sending a dot pattern shall fall within the mask defined in figure 3.

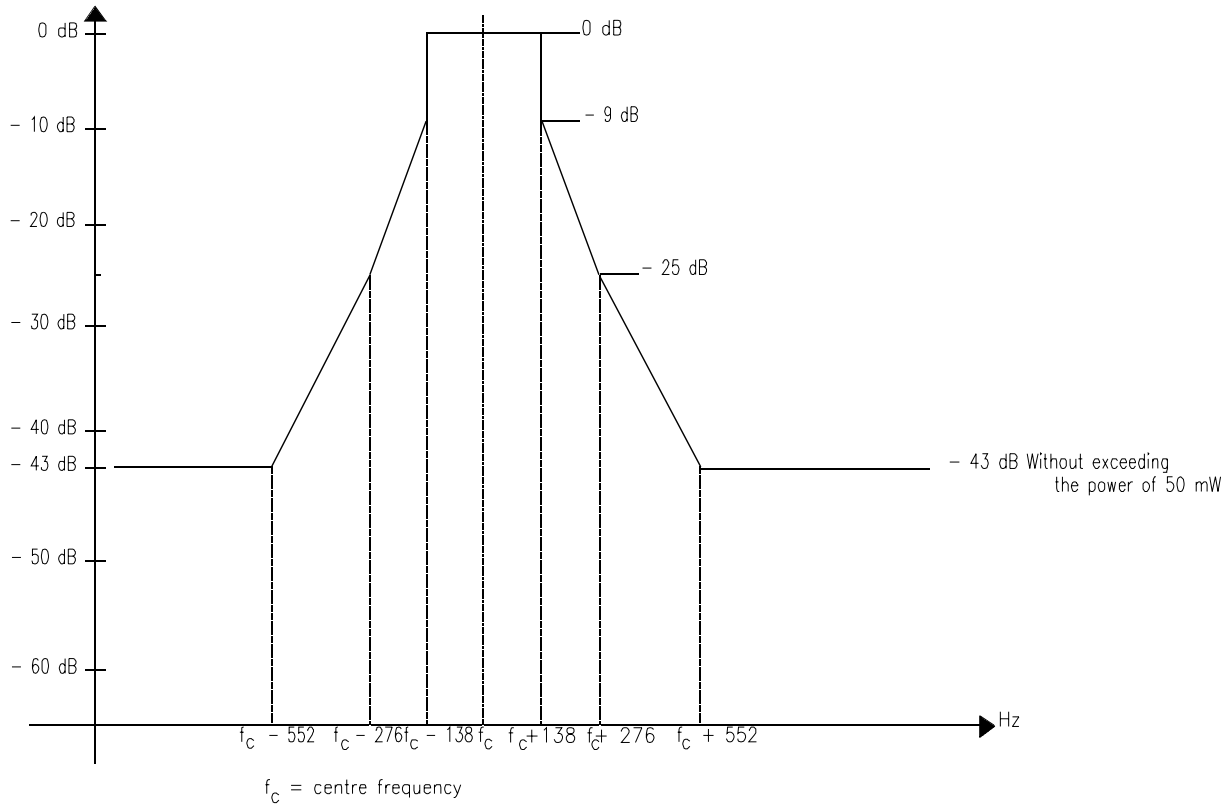


Figure 3: Limits

10.4 Unwanted frequency modulation

10.4.1 Definition

Unwanted frequency modulation is the deviation of output frequency of the transmitter which may occur due to a number of causes but especially when the complete equipment is vibrated over a specified range of frequencies and amplitudes.

10.4.2 Method of measurement

The transmitter complete with chassis covers and shock absorbers (if supplied) shall be clamped in its normal operating position to a vibrating table and shall be connected to the appropriate artificial antenna as specified in clause 5.5.1.

The transmitter shall then be switched on, adjusted for the transmission of class of emission J3E and, after the warming-up period permitted under clause 4.7, shall be modulated by means of a test signal consisting of an audio frequency tone applied to the modulation input at a frequency of 1 000 Hz for SSB telephony or 1 700 Hz for DSC.

The level of the input test signal shall be adjusted to such a level that the output power is 3 dB below the result of the power measurement in clause 7.3.

The transmitter shall be subject to the vibration test sequence described in clause 6.4.1

Any frequency deviation shall be measured by means of a monitoring receiver using a suitable, calibrated, FM demodulator or frequency deviation meter. The deviation meter bandwidth shall be ±125 Hz. The table shall be vibrated as detailed in clause 6.4.

The test shall be performed on 2 182 kHz if the transmitter is designed to work in the 1 605 kHz to 4 000 kHz band only or on a frequency in the 8 MHz band if the equipment is designed to work on all maritime bands in the 1 605 kHz to 27 500 kHz range.

10.4.3 Limits

The frequency peak deviation shall not exceed ±5 Hz.

10.5 Sensitivity of the microphone

10.5.1 Definition

This test shows the capability of the transmitter to produce its full output power, and be fully modulated, when an acoustic tone signal corresponding to the normal mean speech level is applied to the microphone supplied with the equipment.

10.5.2 Method of measurement

An acoustic tone at a frequency of 1 000 Hz and a sound level of 94 dBA shall be applied to the microphone.

10.5.3 Limits

The output power level shall be within -3 dB and -9 dB relative to the maximum output power as measured in clause 10.3.

10.6 Sensitivity of the 600 Ω line input for SSB telephony

10.6.1 Definition

This test shows the capability of the transmitter to produce its full output power, and be fully modulated, when a normal audio line signal level is applied to the 600 Ω line input.

10.6.2 Method of measurement

An audio tone with a frequency of 1 000 Hz and a level of -16 dBm shall be applied to the 600 Ω line input terminals.

The transmitter shall be tuned to the frequency 2 182 kHz for MF equipment or 8 291 kHz for MF/HF equipment.

10.6.3 Limits

The output power level shall be within -3 dB and -9 dB relative to the maximum output power as measured in clause 10.3.

10.7 Automatic level control and/or limiter for SSB telephony

The transmitter shall be equipped with an automatic level control or a limiter of the modulation level, or both, suitable for SSB telephony operation. It shall not be possible for the user to disable this facility.

10.7.1 Method of measurement

The transmitter shall be tuned to the frequency 2 182 kHz for MF equipment or 8 414,5 kHz for MF/HF equipment.

The transmitter shall be connected to the appropriate artificial antenna as specified in clause 5.5.1 and modulated to within 0 dB and -1 dB of the maximum output power as measured under clause 7.3, by a test signal consisting of four audio-frequency tones of equal amplitude, applied to the modulation input, at frequencies of 700 Hz, 1 100 Hz, 1 700 Hz and 2 500 Hz.

Where the level of the test signal is so low as to make its measurement impractical, it is permissible to employ a calibrated attenuator having a characteristic impedance equal to the transmitter input impedance as declared by the manufacturer. The input level to the transmitter may then be calculated from measurements of signal level at the input to the attenuator and the value of attenuation in circuit.

The level of the test signal shall be varied and the peak voltage of the input signal, together with the corresponding values of peak envelope power shall be measured at a sufficient number of points for a graph of input level against peak envelope power to be plotted. The graph shall be placed in figure 4 in such a way that it touches the upper limits at two points at least, without exceeding the upper limits anywhere.

The input signal level corresponding to -10 dB relative to rated output power shall be recorded.

The test shall be repeated using the 600 Ω audio line input.

10.7.2 Limits

The graph shall lie within the limits given in figure 4.

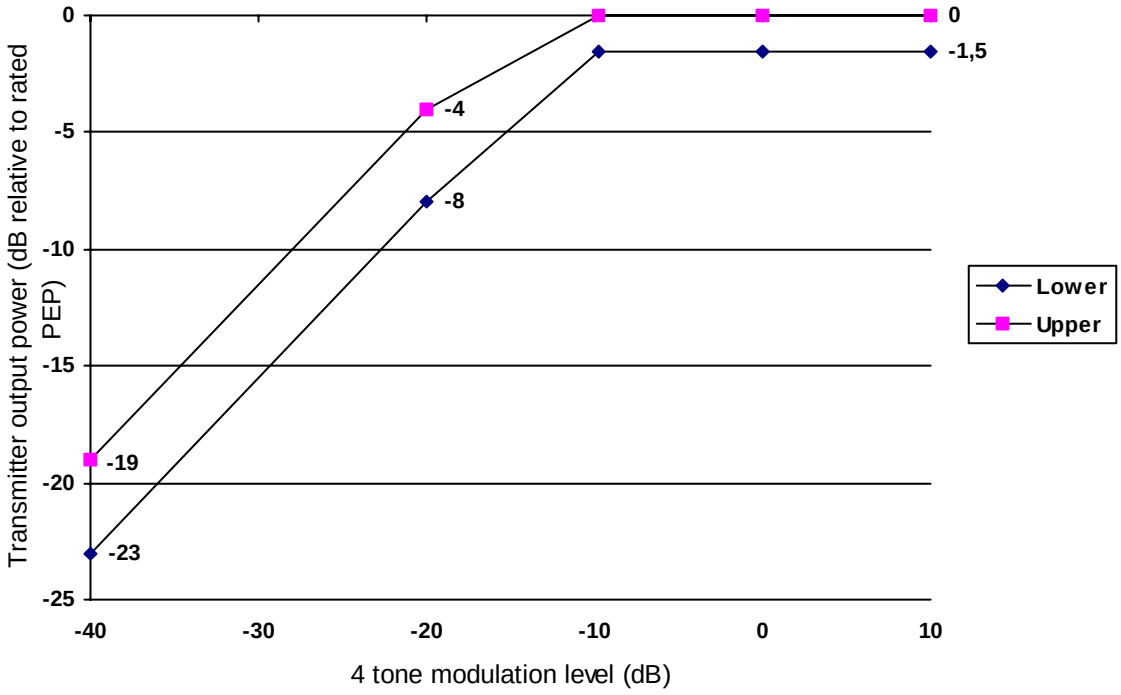


Figure 4: Limits of telephony level control

10.8 Audio frequency response of SSB telephony

10.8.1 Definition

The audio frequency response is the variation of the output power as a function of the modulation audio frequency.

10.8.2 Method of measurement

The transmitter shall be tuned to the frequency 2 182 kHz for MF equipment or 8 291 kHz for MF/HF equipment.

The transmitter shall be connected to the appropriate artificial antenna described in clause 5.5.1 and modulated by a sinusoidal audio frequency test signal connected to the modulation input. The frequency of the test signal shall then be varied between 100 Hz and 10 kHz. The resulting radio frequency power shall be measured at the output of the transmitter using a selective method (e.g. spectrum analyser).

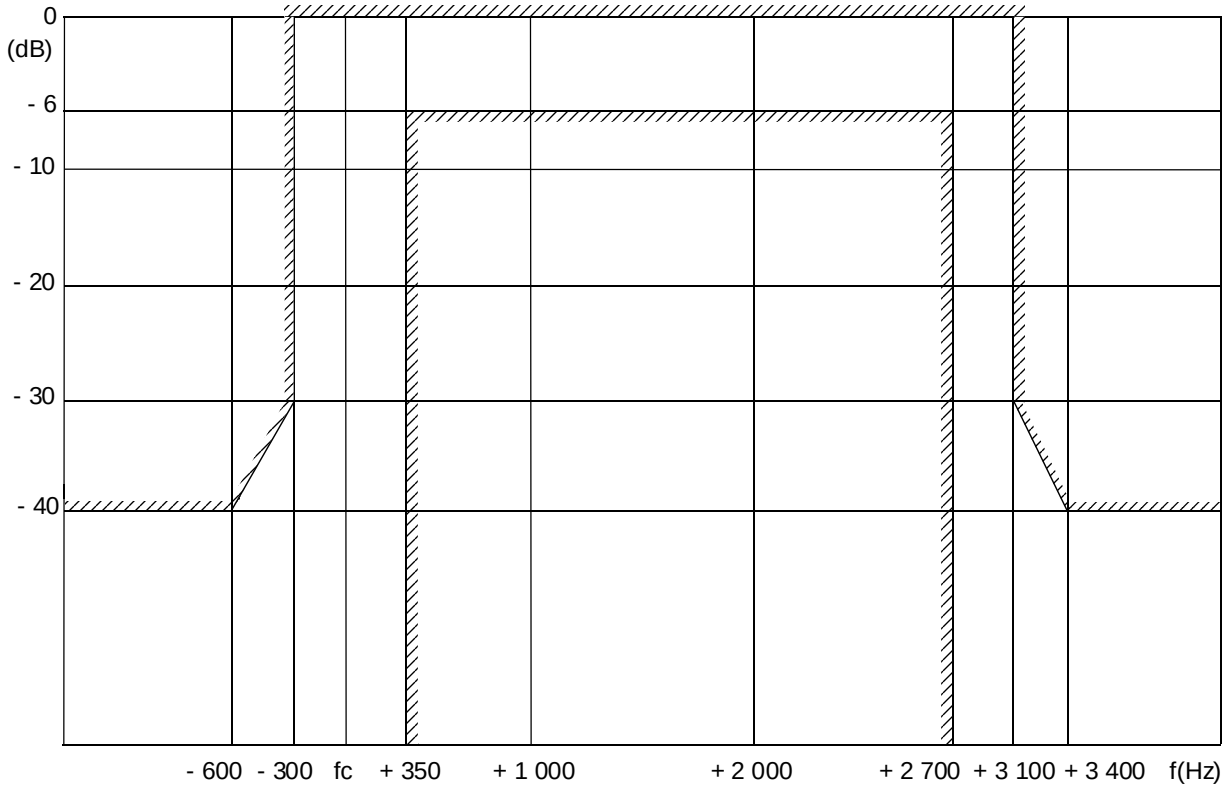
The level of the test signal shall be adjusted so that the output power at the peak of the response characteristic is 10 dB below the rated output power.

The test shall be repeated using the 600 Ω audio line input.

10.8.3 Limits

The graph shown in figure 5 shall be adjusted so that the peak touches the 0 dB line.

The audio frequency response characteristic and its image shall lie between the hatched areas shown in figure 5.



Audio frequency response

Figure 5: Limits of audio frequency response

10.9 Power of out-of-band emissions of SSB telephony

10.9.1 Definition

Out-of band emissions are emissions on a frequency or frequencies immediately outside the necessary bandwidth which result from the modulation process, but excluding spurious emissions.

10.9.2 Method of measurement

The transmitter shall be connected to the appropriate artificial antenna as specified in clause 5.5.1 and driven to the maximum output power measured in clause 7.3 by a modulating signal consisting of two audio-frequency tones with a frequency separation between them such that all intermodulation products occur at frequencies at least 1 500 Hz removed from a frequency 1 400 Hz above the carrier.

The test shall be carried out using the microphone input and the 600 Ω audio line input.

Any limiter or automatic control of the modulation level shall be in normal operation.

10.9.3 Limits

The power of any out-of-band emission supplied to the artificial antenna shall be in accordance with the limits given table 2.

Table 2: Limits for out-of-band emissions

Separation Δ in kHz between the frequency of the out-of-band emission and a frequency 1 400 Hz above the carrier	Minimum attenuation below maximum peak envelope power
1,5 < Δ +/- 4,5	31 dB
4,5 < Δ +/- 7,5	38 dB
7,5 < Δ +/- 12	43 dB without exceeding the power of 50 mW

10.10 Power of conducted spurious emissions of SSB telephony

10.10.1 Definition

Spurious emissions are emissions on a frequency or frequencies that are outside the necessary bandwidth, and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.

10.10.2 Method of measurement

The transmitter shall be connected to a 50 Ω power attenuator. The modulation input shall be terminated by a 600 Ω termination, and the transmitter shall be placed in the transmit mode.

The spurious emissions shall be measured from 9 kHz to 4 GHz. The frequencies ±12 kHz of the assigned frequency shall be excluded from this transmitter test.

Any limiter or automatic control of the modulation level shall be in normal operation.

For stand-alone transmitters this test shall be repeated in the transmitter stand-by mode. The frequencies within the centre frequency fc and fc + 2,7 kHz shall be excluded from this transmitter test.

10.10.3 Limits

The power of any conducted spurious emission at the antenna port shall be in accordance with table 3.

Table 3: Limits for conducted spurious emissions

Frequency range	Minimum attenuation below peak envelope power in Tx mode	Power in the Tx standby mode
9 kHz to 2 GHz	43 dB without exceeding the power of 50 mW	2 nW
>2 GHz to 4 GHz	43 dB without exceeding the power of 50 mW	20 nW

10.11 Residual hum and noise power for telephony

10.11.1 Definition

The residual hum and noise power is that power supplied by the transmitter to the artificial antenna when the modulation input signals are interrupted.

10.11.2 Method of measurement

The transmitter shall be tuned to the frequency 2 182 kHz for MF equipment or 8 291 kHz for MF/HF equipment.

The transmitter shall be connected to the appropriate artificial antenna described in clause 5.5.1. It shall then be modulated by a two-tone test signal to produce the maximum output power as measured in clause 10.3.

The test signal shall then be disconnected from the transmitter modulation input terminals and the radio frequency power shall be measured at the transmitter output within a frequency band which lies between the carrier frequency and 2 700 Hz above the carrier frequency.

The modulation input circuit terminals shall then be short-circuited and the radio frequency power shall be measured again. This test shall be repeated using the 600 Ω audio line input.

10.11.3 Limits

The total residual hum and noise power excluding the carrier shall be at least 40 dB below the peak envelope power.

10.12 Residual frequency modulation on DSC

10.12.1 Definition

The residual frequency modulation of the transmitter is defined as the ratio in dB of the demodulated B or Y signal relative to the demodulated dot pattern.

10.12.2 Method of measurement

The transmitter shall be connected to the appropriate artificial antenna described in clause 5.5.1. It shall then be modulated by a dot pattern to produce the maximum output power as measured in clause 10.3.

The RF output terminal of the equipment shall be fed to a suitable, calibrated, FM demodulator. The output of the demodulator shall be limited in bandwidth by a low-pass filter with a cut-off frequency of 1 kHz and a slope of 12 dB/octave. DC voltages shall be suppressed by an ac coupling device so that they do not influence the result of the measurement.

The RMS output level shall be measured during continuous transmission of the B or Y signal and during the transmission of continuous dot pattern.

The ratio of the two measured RMS output levels from the demodulator shall be determined.

10.12.3 Limits

The residual frequency modulation shall not be greater than -26 dB.

10.13 Carrier suppression

10.13.1 Definition

The carrier suppression is expressed in terms of the ratio between the peak envelope power and the carrier power output power.

10.13.2 Method of measurement

The transmitter shall be connected to the appropriate artificial antenna described in clause 5.5.1. It shall then be modulated by an audio frequency of 1 000 Hz to produce the maximum output power as measured in clause 10.3.

The carrier suppression shall be measured in J3E mode.

The test shall be performed under both normal (see clause 5.3) and extreme test conditions (see clauses 5.4.1 and 5.4.2 applied simultaneously).

10.13.3 Limits

The carrier suppression for modulation J3E shall be at least 40 dB.

10.14 Continuous operation on telephony

Continuous operation of the transmitter is the ability to produce full rated RF output power without interruption for a specified time.

10.14.1 Definition

10.14.2 Method of measurement

The transmitter shall be connected to the artificial antenna as specified in clause 5.5.1 and driven to its maximum output power measured under clause 7.3 using the two-tone test signal as described in clause 10.3.2. The equipment shall transmit continuously for a period of 15 min.

The transmitter shall be tuned to the frequency 2 182 kHz for MF equipment or 8 291 kHz for MF/HF equipment.

The measurement shall be carried out under normal (see clause 5.3) and extreme test conditions (see clauses 5.4.1 and 5.4.2 applied simultaneously).

10.14.3 Limits

The output power shall not vary by more than ±1,5 dB from the rated output power. The limits of clause 10.3.3 shall not be exceeded.

10.15 Protection of transmitter

10.15.1 Definition

This represents the protection afforded to the transmitter against damage which may be caused by faults occurring in the ship's transmitting antenna.

10.15.2 Method of measurement

After the transmitter has been tuned and whilst the transmitter is being driven to the rated output power by the simultaneous application of two modulating signals of equal level, the antenna terminals shall first be short-circuited and then open-circuited, in each case for a period of 5 min. This test shall be conducted on one frequency only. The frequency chosen shall be recorded in the test report.

10.15.3 Limits

This test shall not result in any damage to the transmitter. After removal of the short-circuit or open-circuit conditions, the transmitter shall be able to operate normally for all available modes.

11 Receiver

11.1 Receiver output powers

11.1.1 Standard output power

For the purposes of the following clauses, the standard output power is defined as:

a) 1 mW for earphone reception;

b) 500 mW for loudspeaker reception;

c) 0 dBm into 600 Ω for the audio line outputs;

and shall be measured across a resistor equal to the nominal value of the load impedance as declared by the manufacturer.

11.1.2 Rated output power

The rated output power of the receiver is the output power declared by the manufacturer which should be at least 2 W. The total harmonic distortion at the rated output power shall meet the requirements in clause 8.12.3.

11.2 Frequency error

11.2.1 Definition

The frequency error of the receiver is:

a) for SSB telephony:

- the absolute frequency error of the 1 000 Hz output frequency when the receiver is tuned to the carrier frequency using the input signal defined in clause 5.6.2.1;

b) for DSC with an analogue interface:

- the absolute frequency error of the 1 700 Hz output frequency when the receiver is tuned to the assigned frequency using input signal defined in clause 5.6.2.3.

11.2.2 Method of measurement

a) SSB telephony:

- a standard input signal for J3E at a level of +60 dBµV shall be applied to the receiver on the nominal frequency to which it is tuned. The frequency of the output at the 600 Ω terminals shall be measured and its difference from 1 000 Hz be recorded;

b) DSC with analogue input:

- a standard input signal for F1B shall be applied to the receiver on the assigned frequency to which it is tuned at level of +60 dBµV. The frequency of the output on the DSC 600 Ω terminals shall be measured and its difference from 1 700 Hz be recorded.

Measurement shall be made under normal test conditions (see clause 5.3) and under extreme test conditions (see clauses 5.4.1 and 5.4.2 applied simultaneously).

11.2.3 Limits

The frequency error shall be less than ±10 Hz, after the warming up period specified in clause 4.7.

11.3 Unwanted frequency modulation

11.3.1 Definition

Unwanted frequency modulation is the deviation of output frequency which may occur due to a number of causes but especially when the complete equipment is vibrated over a specified range of frequencies and amplitudes.

11.3.2 Method of measurement

The receiver, complete with chassis covers and shock absorbers (if supplied), shall be clamped in its normal operating position to a vibrating table.

The receiver shall then be switched on, adjusted for the reception of class of emission J3E and after the warming-up period permitted under clause 4.7 a radio frequency test signal as detailed in clause 5.6.2.3 shall be applied to its input at a level of +60 dBµV.

The receiver shall be adjusted to deliver standard output power at 1 kHz.

The receiver shall be subject to the vibration test sequence described in clause 6.4.1

Any frequency deviation of the output signal occurring during this test, shall be measured using a suitable, calibrated, FM demodulator. The deviation meter bandwidth shall be ±125 Hz.

If the receiver does not have telephony facilities then the same test is performed using the reception of class of emission F1B with the appropriate test signal at the same levels but with an output frequency of 1 700 Hz.

11.3.3 Limits

The frequency peak deviation shall not exceed ±5 Hz.

11.4 Pass band

11.4.1 Definition

The pass band measured at the output of the receiver, is the frequency band in which the attenuation relative to peak response does not exceed 6 dB.

11.4.2 Method of measurement

11.4.2.1 Class of emission J3E

The receiver shall be tuned to the frequency 2 182 kHz for MF equipment or 8 291 kHz for MF/HF equipment.

With the AGC operative, two unmodulated radio frequency test signals shall be applied to the input of the receiver in accordance with clause 5.6.1.1.

The frequency of one of these test signals shall be at a frequency 1 500 Hz above the carrier frequency to which the receiver is tuned, and its level shall be + 60 dBµV. This stabilizes the gain of the receiver. The other test signal shall be at a level + 50 dBµV and shall be varied in frequency from the nominal carrier frequency to 10 kHz above the carrier frequency. Its resultant audio output voltage and frequency shall be measured at a sufficient number of points, using a spectrum analyser or selective voltmeter, to enable the audio frequency pass band to be determined.

When measuring in the vicinity of 1 500 Hz, the frequency of the gain-stabilizing input signal shall be displaced to a frequency just outside the pass-band of the measuring instrument.

11.4.3 Limits

The audio frequency pass band shall exceed 350 Hz to 2 700 Hz.

11.5 Maximum usable sensitivity

11.5.1 Definition

The maximum usable sensitivity is the minimum level of a radio frequency input signal with specified modulation which will produce at the receiver analogue outputs a chosen value of Signal plus Noise plus Distortion to Noise plus Distortion (SINAD) ratio and, at the same time an output power not less than the standard output power.

In the case of digital outputs it is the minimum level of a radio frequency input signal with specified modulation which will produce a chosen value of bit error ratio.

11.5.2 Methods of measurement

With the AGC operative, tests shall be carried out with the receiver adjusted for each frequency range and class of emission for which it is designed. The test input signal to the receiver shall be the normal test signals specified in clause 5.6.2.

For each test the input level of the test signal shall be adjusted until the SINAD ratio at the receiver output is 20 dB or the bit error ratio is less than 10^{-2} and at the same time at least the standard output power or levels are obtained. The measured input level is the maximum usable sensitivity. Where a bit error ratio test is carried out the tests shall be repeated with the input signal ±10 Hz of its nominal value.

Measurement shall be made under normal test conditions (see clause 5.3) and under extreme test conditions (see clauses 5.4.1 and 5.4.2 applied simultaneously).

11.5.3 Limits

The maximum usable sensitivity shall be better than the values given in table 4.

Table 4: Limits of maximum usable sensitivity

Frequency range	**Class of emission**	**Maximum level of input of input signal (dBµV) 50 Ω or 10 Ω and 250 pF source impedance**	
		Normal conditions	Extreme conditions
1 605 to 4 000 kHz			
	J3E	+16	+22
	F1B	+5	+11
4 to 27,5 MHz			
	J3E	+11	+17
	F1B	+0	+6

11.6 Adjacent signal selectivity

11.6.1 Definition

Adjacent signal selectivity is defined as the ability of the receiver to discriminate between a wanted signal (to which the receiver is tuned) and unwanted signals existing simultaneously in channels adjacent to that of the wanted signal or a increase of the bit error ratio to 10^{-2}.

11.6.2 Method of measurement

The arrangements for applying two test signals to the receiver input, shall be according to clause 5.6.1. The AGC shall be in operation.

The wanted signal shall be in accordance with clause 5.6.2.

Class of emission J3E and Class of emission F1B (analogue output)

Analogue receivers shall be adjusted to give standard output power on the wanted frequency, and to give a SINAD ratio, of 20 dB.

The level of the unwanted signal shall be increased (starting from a low level), until the SINAD ratio, is decreased from 20 dB to 14 dB or the bit error ratio decreases to 10^{-2}.

Class of emission F1B (Digital output)

NOTE: Measurement on F1B are only required if the receiver does not have the J3E mode.

The wanted signal level shall be 20 dBµV, and shall be modulated with the sequence from the BER generator. The unwanted signal shall have a level of +60 dBµV and be unmodulated.

Digital receivers shall have a bit error ratio of better than 10^{-2}.

The wanted signal level shall be +20 dBµV.

11.6.3 Limits

The adjacent signal selectivity shall exceed the values given in the tables 5, 6, 7 and 8.

Table 5: Class of emission J3E

Carrier frequency of unwanted signal relative to carrier frequency of wanted signal	Adjacent signal selectivity
-1 kHz and +4 kHz	40 dB
-2 kHz and +5 kHz	50 dB
-5 kHz and +8 kHz	60 dB

Table 6: Class of emission F1B

Carrier frequency of unwanted signal relative to carrier frequency of wanted signal	Adjacent signal selectivity
-500 Hz and +500 Hz	40 dB

Table 7: Class of emission F1B (Digital output)

Carrier frequency of unwanted signal relative to carrier frequency of wanted signal	Adjacent signal selectivity
-500 Hz and +500 Hz	BER = 10^{-2} or better

11.7 Blocking or desensitization

11.7.1 Definition

Blocking is a change (generally a reduction) in the wanted output power of a receiver, or a reduction in the SINAD ratio, or an increase in the bit error rate due to an unwanted signal on another frequency.

11.7.2 Method of measurement

The tests shall be carried out in J3E with the AGC operative, the RF/IF gain control (if provided) at its maximum, and any input attenuator adjusted to minimum attenuation. The measurements shall be made by means of the simultaneous application of two test signals to the input of the receiver. One of the test signals is the wanted signal to which the receiver is tuned, and the other is the unwanted signal.

Class of emission J3E or F1B (analogue output)

Measurements shall be carried out with an input level of the wanted signal of +60 dBµV and repeated with the wanted signal at a level equal to the maximum usable sensitivity of the receiver as measured in clause 8.5.

The wanted test input signal to the receiver shall be the normal test signal specified in clause 5.6.2.

The receiver shall be adjusted so that the wanted signal gives standard output power.

The unwanted signal shall have a frequency of ±20 kHz relative to that of the wanted signal.

The unwanted signal shall be unmodulated. The input level of the unwanted signal shall be adjusted until either it causes a change of 3 dB in the output level of the wanted signal, or until it causes a reduction of the SINAD ratio of 6 dB, whichever effect occurs first. The input level of the unwanted signal, when the specified condition is reached, shall be taken as the blocking level.

Class of emission F1B (digital output)

NOTE: Measurement on F1B are only required if the receiver does not have the J3E mode.

Measurements shall be carried out with an input level of the wanted signal of +60 dBµV.

The unwanted signal shall be unmodulated. The input level of the unwanted signal shall be set to a level of +100 dBµV.

11.7.3 Limits

Class of emission J3E or F1B (analogue output).

With the wanted signal at +60 dBµV, the level of the unwanted signal shall be not less than 100 dBµV.

With the wanted signal at a level equal to the measured maximum usable sensitivity, the level of the unwanted signal shall be at least +65 dB above the measured usable sensitivity level.

Class of emission F1B (digital output)

The bit error ratio shall be 10^{-2} or better.

11.8 Intermodulation response

11.8.1 Definition

Intermodulation is a process by which signals are produced from two or more (generally unwanted) signals simultaneously present in a non-linear circuit.

11.8.2 Method of measurement

11.8.2.1 Class of emission J3E.

With the AGC operative, the RF/IF gain control (if provided) at its maximum, and any input attenuator adjusted to minimum attenuation, an unmodulated input signal 1 000 Hz higher than the frequency to which the receiver is tuned shall be applied to the receiver input at a level of +30 dBµV and the audio frequency gain control shall be adjusted to give standard output power.

With the wanted signal still applied, two equal level unmodulated signals shall be simultaneously applied to the input of the receiver, neither of these two signals shall have a frequency within 30 kHz from the wanted signal.

When choosing the frequencies used for this measurement, care should be taken to avoid frequencies at which spurious responses occur.

NOTE: Input frequencies likely to cause unwanted intermodulation products are described in ITU-R Recommendation 332-4, clause 6.4 (see bibliography).

The input levels of the two interfering signals shall remain equal and shall be adjusted to reduce the SINAD ratio at the receiver output to 20 dB, carefully adjusting the frequency of one of the unwanted signals to maximize the reduction in SINAD ratio.

11.8.2.2 Class of emission F1B analogue

With the AGC operative, the RF/IF gain control (if provided) at its maximum, and any input attenuator adjusted to minimum attenuation, an unmodulated input signal on the assigned frequency shall be applied to the receiver input at a level of +20 dBµV.

With the wanted signal still applied, two equal level unmodulated signals shall be simultaneously applied to the input of the receiver, neither of these two signals shall have a frequency within 30 kHz from the wanted signal.

When choosing the frequencies used for this measurement, care should be taken to avoid frequencies at which spurious responses occur.

NOTE: Input frequencies likely to cause unwanted intermodulation products are described in ITU-R Recommendation 332-4, clause 6.4 (see bibliography).

The input levels of the two interfering signals shall remain equal and shall be adjusted to reduce the SINAD ratio at the receiver output to 20 dB, carefully adjusting the frequency of one of the unwanted signals to maximize the reduction in SINAD ratio.

11.8.2.3 Class of Emission F1B digital

With the AGC operative, the RF/IF gain control (if provided) at its maximum, and any input attenuator adjusted to minimum attenuation, a signal on the assigned frequency shall be applied to the receiver input at a level of +20 dBµV, modulated with a signal of 100 baud with a frequency shift of ±85 Hz suitable for bit error ratio tests.

Two equal level unmodulated signals shall be simultaneously applied to the input of the receiver, neither of these two signals shall have a frequency within 30 kHz from the wanted signal.

When choosing the frequencies used for this measurement, care should be taken to avoid frequencies at which spurious responses occur.

NOTE: Input frequencies likely to cause unwanted intermodulation products are mentioned in ITU-R Recommendation 332-4, clause 6.4 (see bibliography).

The input levels of the two interfering signals shall remain equal and shall be adjusted to reduce the bit error ratio at the receiver output to 10^{-2}, carefully adjusting the frequency of one of the unwanted signals to maximize the reduction in bit error ratio.

11.8.3 Limits

The level of each of the two interfering signals which result in a 20 dB SINAD ratio at the receiver output shall be not less than +80 dBµV for J3E and +70 dBµV for analogue F1B.

The level of each of the two interfering signals which result in a bit error ratio of 10^{-2} for digital receivers shall be not less than +70 dBµV.

11.9 Reciprocal mixing

11.9.1 Definition

Reciprocal mixing is the transfer of the noise sidebands of the receivers local oscillator(s) to a wanted signal due to the presence of a large wanted or unwanted signal.

11.9.2 Method of measurement

The measurement shall be carried out with the receiver in the mode of operation J3E, with the AGC operative, the RF/IF gain control (if fitted) at its maximum and any input attenuator at its minimum attenuation. The measurements shall be made by the simultaneous application of two test signals to the input of the receiver. One of the test signals is the wanted signal to which the receiver is tuned and the other the unwanted signal.

The wanted test signal shall be the normal test signal specified in clause 5.6.2 with a level of +60 dBµV. The receiver shall be adjusted so that the wanted signal gives standard output power.

The unwanted signal shall have a frequency separation of ±20 kHz, or more, relative to that of the receiver frequency and shall be unmodulated.

The input level of the unwanted signal is adjusted until it causes a reduction in the SNR to 30 dB. The input level of the unwanted signal is recorded and shall be taken as the reciprocal mixing level.

Care should be taken in the measurement to avoid the effects of distortion.

Care should be taken to ensure that the noise sideband of the generators representing the wanted, and especially the unwanted signals, do not influence the measurements.

11.9.3 Results

The reciprocal mixing level shall be not less than +100 dBµV.

11.10 Spurious response rejection ratio

11.10.1 Definition

The spurious response rejection ratio is the ratio of the input level of an unwanted signal, at the frequency of the spurious response to the input level of a wanted signal, when the wanted and unwanted signals individually produce the same SINAD ratio at the receiver output.

11.10.2 Method of measurement

Frequencies likely to cause a spurious response are at the image frequencies of the mixers and at the various IF frequencies used in the receiver.

Manufactures should provide the test house with a simple block diagram showing:

- the IF frequencies used;
- the local oscillator frequencies used;
- the coverage range;
- the pre first mixer filtering arrangements.

Test should be made with a wanted frequency on 2 182 kHz for J3E receivers and 2 187,5 kHz for F1B receivers if the coverage is between 1 605 and 4 000 kHz and 8 291 kHz for J3E receivers and 8 376,5 kHz for F1B receivers if the coverage is between 1 605 kHz and 27,5 MHz.

NOTE: Measurements on F1B are only required if the receiver does not have the J3E mode.

The following tests shall be made:

- a complete search of the coverage range;
- a measurement of all IF frequencies outside that range;
- a measurement of all frequencies defined by:

$n * f_{lo1} +/- f_{if1}$

$p * f_{receive} +/- f_{if1}$

$(f_{lo2} +/- f_{if2}) +/- f_{lo1}$

where n and p are integers and f_{lo1} is the local oscillator frequency of the first mixer, f_{if1} is the first IF frequency and f_{lo2} is the local oscillator frequency of the second mixer, f_{if2} is the second IF frequency.

If the measurements are within 10 dB of the limit, the integers n & p need not exceed 10, otherwise the upper frequency of the test shall be 2 GHz.

Care should be taken when measuring IF rejection within the coverage range.

If the wanted signal frequency causes a filter to be introduced that improves the IF response, then another wanted frequency should be chosen in the same band as the IF frequency without being closer than 100 kHz of the IF frequency.

Where measurements are made close to the wanted signal, the levels and tests provided for these conditions in the present document shall take precedence. No testing is necessary closer than 20 kHz to the wanted signal.

The receiver shall be set up in accordance with clause 8.5. All receiver controls shall remain unaltered during the remainder of the test.

Two signal generators A and B shall be connected to the receiver input via a combining network so that they do not affect the impedance matching.

Class of emission J3E and Class of emission F1B (analogue output)

The wanted signal represented by signal generator A shall be at the nominal frequency and shall have test modulation according to clause 5.6.2, the level shall be at the sensitivity level required in table 3.

Signal generator B shall have a level of at least 80 dB above the level of signal generator A, and the frequencies shall be according to the above mentioned.

For each spurious response found the carrier frequency of the input signal shall be adjusted to give maximum output power. The input level shall then be adjusted until a SINAD ratio of 14 dB at the output of the receiver is achieved.

The ratio between the input level of each spurious signal and the input of the wanted signal giving the same SINAD ratio, shall then be evaluated.

Class of emission F1B (Digital output)

The level of signal generator A shall be 3 dB above the sensitivity level required in table 4.

Signal generator B shall be at the level 70 dB above the level of signal generator A, and the frequencies shall be according to the above mentioned.

11.10.3 Limits

Class of emission J3E and Class of emission F1B (analogue output)

The spurious response rejection ratio shall not be less than 60 dB.

Class of emission F1B (Digital output)

The bit error ratio shall be 10^{-2} or better.

11.11 Harmonic content in output

11.11.1 Definition

The harmonic content in the output of a telephony receiver is the total RMS voltage of all the individual harmonics of modulation frequencies, appearing at the receiver outputs as a result of non-linearity in the receiver. For purposes of test it is expressed as a percentage of the total RMS output voltage, when a single sinusoidal modulation is applied.

11.11.2 Method of measurement

This test shall be performed with rated output power and with standard output power. The test signals as defined in clause 5.6.2 shall be applied to the receiver input applicable for all modes of analogue modulation.

The level of the input signal shall be varied between +30 dBµV and +80 dBµV, while maintaining the output level at the standard output power and then at the rated output power. The harmonic content shall then be measured.

11.11.3 Limits

The harmonic content shall not exceed 10 % at rated output power and 5 % at standard output power.

11.12 Audio frequency intermodulation

11.12.1 Definition

Audio frequency intermodulation is a process by which signals are produced from two or more wanted signals simultaneously present in the demodulator and/or audio amplifier of a telephony receiver. It is expressed in terms of the ratio of the level of each intermodulation component relative to the level of one or two test signals of equal amplitude.

11.12.2 Method of measurement

With the AGC operative, the manual RF/IF gain control (if provided) at its maximum, and any input attenuator adjusted to its minimum attenuation, an unmodulated signal, 1 100 Hz above the frequency to which the receiver is tuned, at a level of + 60 dBµV shall be applied to the input of the receiver. In addition a second unmodulated signal, 1 700 Hz above the frequency to which the receiver is tuned shall be applied and its level shall be adjusted until the 1 100 Hz and the 1 700 Hz signals in the output of the receiver are of equal amplitude.

By means of the audio frequency gain control the total output power of the receiver shall be adjusted to standard output power (see clause 11.1).

The audio frequency intermodulation components shall then be measured.

11.12.3 Limits

The value of any of the intermodulation components shall not exceed -25 dB relative to the output level of any one of the two wanted signals.

11.13 Spurious emissions

11.13.1 Definition

Spurious emissions are any radio frequency emissions generated in the receiver and radiated either by way of conduction to the antenna or other conductors connected to the receiver, or radiated directly by the receiver. For the purposes of the present document only spurious emissions conducted by way of the antenna shall be considered.

11.13.2 Methods of measurement

The receiver antenna port shall be terminated into 50 Ω and a search shall be made for the presence of signals appearing across the resistor. The measurement shall be made over the frequency range 9 kHz to 4 GHz.

11.13.3 Limits

The power of any discrete component measured into 50 Ω shall not exceed 2 nW from 9 kHz to 2 GHz and 20 nW from 2 GHz to 4 GHz.

11.14 Internally generated spurious signals

11.14.1 Definition

Internally generated spurious signals are those signals that may appear in the output of a receiver due to mixing processes in the receiver system without any antenna input signal.

11.14.2 Method of measurement

The receiver shall have no input signal and be terminated at its antenna input with a load impedance equal to those specified in clause 5.5. The receiver shall be set to J3E mode and a search made throughout the bands for whistles in the output. For conformance testing manufacturers may need to provide a means for quickly searching the bands in steps of no more than 1 kHz.

11.14.3 Limits

There shall be no internally generated spurious signals on any designated distress frequency and its associated guard bands. On all other channels where spurious occur, the level shall be less than 10 dB above the inherent noise level.

11.15 AGC efficiency

11.15.1 Definition

The AGC efficiency of the receiver is the ability to keep the change of audio output level within limits when the RF input voltage is varied over a specified range.

11.15.2 Method of measurement and limits

11.15.2.1 Settings

To check the performance of the AGC, tests shall be carried out with the receiver adjusted for each maritime mobile band. The input signal shall be the appropriate normal test signal specified in clause 5.6.2. The characteristics shall be checked at all audio outputs.

11.15.2.2 Increase in Signal-to-Noise Ratio (SNR)

For each test the input signal shall have a level equal to the maximum usable sensitivity measured according to clause 11.5. The input level shall then be increased by 20 dB. The SNR shall then increase by at least 15 dB.

Care should be taken in the measurement to avoid the effects of distortion.

11.15.2.3 Range

Under the test conditions specified in clause 11.16.2.1 the receiver shall be adjusted to give an output level 10 dB below the standard output power. The input level shall then be increased by 70 dB. The resulting increase in output power shall not exceed 10 dB.

11.16 AGC time constants (attack and recovery time)

11.16.1 Definitions

AGC attack time: the elapsed time from the instant at which the input-signal level is suddenly increased by a specified amount, until the instant at which the level of the output signal reaches and remains within ±2 dB of the subsequent steady-state value.

AGC recovery time: the elapsed time from the instant when the input-signal level is suddenly decreased by a specified amount, until the instant at which the output signal reaches and remains within ±2 dB of the subsequent steady-state value.

11.16.2 Method of measurement

A test signal (see clause 5.6.2) shall be applied to the input of the receiver set in the J3E mode via an attenuator capable of being switched in a single step of 30 dB without interrupting the test signal. The resulting audio output shall be displayed by means of an oscilloscope.

The input level shall be adjusted to produce an output SNR ratio of 20 dB, and the output level adjusted to 10 dB below the standard audio-frequency output power. The attenuator shall then be switched so that the input signal increases in level by 30 dB.

The attack time shall then be measured. The attenuator shall then be switched so that the input signal returns to its original level. The recovery time shall be measured.

Care should be taken in the measurement to avoid the effects of distortion.

11.16.3 Limits

Attack time: 5 to 10 ms;

Recovery Time: 1 to 4 s.

11.17 Protection of input circuits

11.17.1 Definition

The protection of the input circuits is the ability of the antenna input to stand large voltages for a specified time.

11.17.2 Method of measurement

An unmodulated radio frequency test signal, at a level of 30 V RMS is applied, in the manner specified in clause 5.6 to the receiver input for a period of 15 min.

The test shall be performed on 2 182 kHz if the equipment is designed to operate in the 1 605 kHz to 4 000 kHz bands only, or on a frequency in the 8 MHz band if the equipment is designed to operate on all maritime bands in the 1 605 kHz to 27 500 kHz range.

11.17.3 Limit

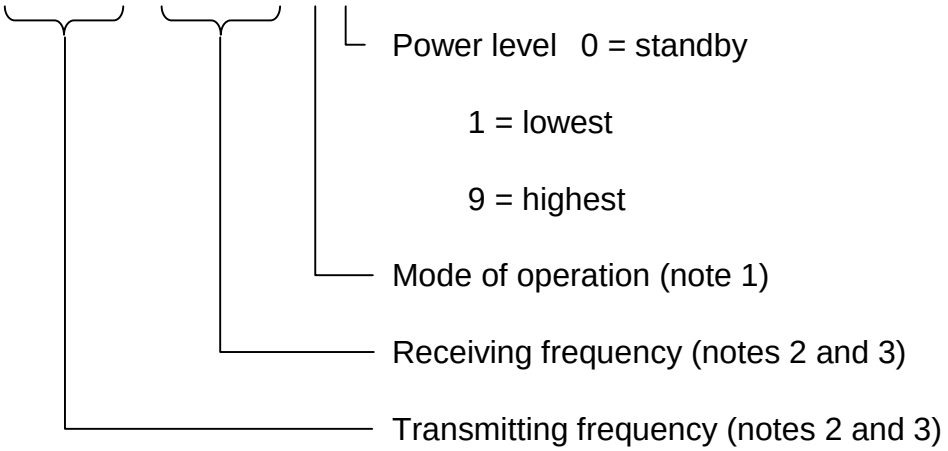
The receiver shall operate normally without further attention when the test signal is removed.

Annex A (normative): Protocol for the IEC 61162-1 Commands Frequency Set Information (FSI)

A.1 Frequency Set Information (FSI)

This sentence is used to set frequency, mode of operation and transmitter power level of a radiotelephone, to read out frequencies, mode and power and to acknowledge setting commands. Details are shown in Figure A.1.

$--FSI,xxxxxx,xxxxxx,c,x*hh<CR><LF>



NOTE 1: Mode of operation:
- d = F3E/G3E simplex, telephone;
- e = F3E/G3E duplex, telephone;
- m = J3E, telephone;
- o = H3E, telephone;
- q = F1B/J2B FEC NBDP, TELEX/teleprinter;
- s = F1B/J2B ARQ NBDP, TELEX/teleprinter;
- t = F1B/J2B receive only, teleprinter/DSC;
- w = F1B/J2B, teleprinter/DSC;
- x = A1A Morse, tape recorder;
- { = A1A Morse, morse key/head set;
- | = F1C/F2C/F3C, FAX-machine;
- null for no information.

NOTE 2: Frequencies to be in 100 Hz increments.
MF/HF telephone channels to have first digit 3, followed by ITU channel numbers with leading zeros as required.
MF/HF teletype channels to have first digit 4; the second and third digit give the frequency bands, and the fourth to sixth digits ITU channel numbers; each with leading zeros as required.
VHF channels to have first digit 9 followed by zero. The next number is "1" indicating the ship station's transmit frequency is being used as a simplex channel frequency, or "2" indicating the coast station's transmit frequency is being used as a simplex channel frequency, "0" otherwise. The remaining three numbers are the VHF channel numbers with leading zeros as required.

NOTE 3: For paired frequencies the transmitting frequency only need to be included; null for receiving frequency field. For receive frequencies only, the transmitting frequency field shall be null.

Figure A.1: Frequency set information

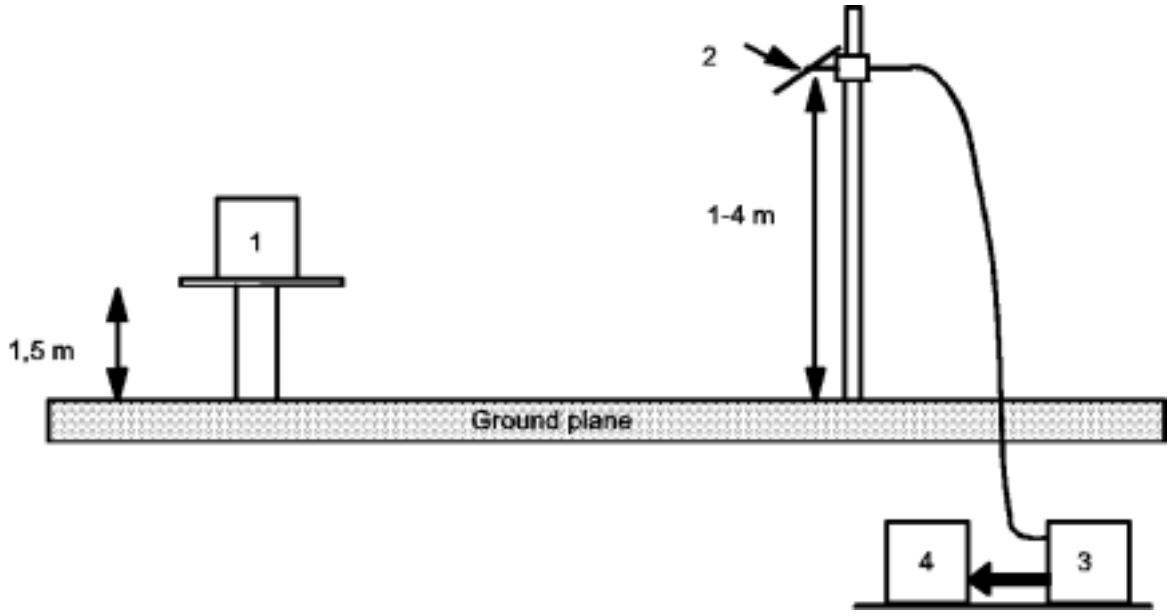
Annex B (normative): Radiated measurements

B.1 Test sites and general arrangements for measurements involving the use of radiated fields

B.1.1 Outdoor test site

The outdoor test site shall be on a reasonably level surface or ground. At one point on the site, a ground plane of at least 5 m diameter shall be provided. In the middle of this ground plane, a non-conducting support, capable of rotation through 360° in the horizontal plane, shall be used to support the test sample at 1,5 m above the ground plane. The test site shall be large enough to allow the erection of a measuring or transmitting antenna at a distance of lambda/2 or 3 m whichever is the greater. The distance actually used shall be recorded with the results of the tests carried out on the site.

Sufficient precautions shall be taken to ensure that reflections from extraneous objects adjacent to the site and ground reflections do not degrade the measurements results.



Key:
1 - Equipment under test
2 - Test antenna
3 - High pass filter (necessary for strong fundamental Tx radiation)
4 - Spectrum analyser or measuring receiver

Figure B.1: Outdoor Test Site

B.1.2 Test antenna

The test antenna is used to detect the radiation from both the test sample and the substitution antenna, when the site is used for radiation measurements; where necessary, it is used as a transmitting antenna, when the site is used for the measurement of receiver characteristics.

This antenna is mounted on a support such as to allow the antenna to be used in either horizontal or vertical polarization and for the height of its centre above ground to be varied over the range 1 m to 4 m. Preferably a test antenna with pronounced directivity should be used. The size of the test antenna along the measurement axis shall not exceed 20 % of the measuring distance.

For receiver and transmitter radiation measurements, the test antenna is connected to a measuring receiver, capable of being tuned to any frequency under investigation and of measuring accurately the relative levels of signals at its input. For receiver radiated sensitivity measurements the test antenna is connected to a signal generator.

B.1.3 Substitution antenna

When measuring in the frequency range up to 1 GHz the substitution antenna shall be a lambda/2 dipole, resonant at the frequency under consideration, or a shortened dipole, calibrated to the lambda/2 dipole. When measuring in the frequency range above 4 GHz a horn radiator shall be used. For measurements between 1 GHz and 4 GHz either a lambda/2 dipole or a horn radiator may be used. The centre of this antenna shall coincide with the reference point of the test sample it has replaced. This reference point shall be the volume centre of the sample when its antenna is mounted inside the cabinet, or the point where an external antenna is connected to the cabinet.

The distance between the lower extremity of the dipole and the ground shall be at least 0,3 m.

The substitution antenna shall be connected to a calibrated signal generator when the site is used for spurious radiation measurements and transmitter effective radiated power measurements. The substitution antenna shall be connected to a calibrated measuring receiver when the site is used for the measurement of receiver sensitivity.

The signal generator and the receiver shall be operating at the frequencies under investigation and shall be connected to the antenna through suitable matching and balancing networks.

NOTE: The gain of a horn antenna is generally expressed relative to an isotropic radiator.

B.1.4 Optional additional indoor site

When the frequency of the signals being measured is greater than 80 MHz, use may be made of an indoor site. If this alternative site is used, this shall be recorded in the test report.

The measurement site may be a laboratory room with a minimum area of 6 m by 7 m and at least 2,7 m in height.

Apart from the measuring apparatus and the operator, the room shall be as free as possible from reflecting objects other than the walls, floor and ceiling.

The potential reflections from the wall behind the equipment under test are reduced by placing a barrier of absorbent material in front of it. The corner reflector around the test antenna is used to reduce the effect of reflections from the opposite wall and from the floor and ceiling in the case of horizontally polarized measurements. Similarly, the corner reflector reduces the effects of reflections from the side walls for vertically polarized measurements. For the lower part of the frequency range (below approximately 175 MHz) no corner reflector or absorbent barrier is needed. For practical reasons, the lambda/2 antenna in figure B.2 may be replaced by an antenna of constant length, provided that this length is between lambda/4 and lambda at the frequency of measurement and the sensitivity of the measuring system is sufficient. In the same way the distance of lambda/2 to the apex may be varied.

The test antenna, measuring receiver, substitution antenna and calibrated signal generator are used in a way similar to that of the general method.

To ensure that errors are not caused by the propagation path approaching the point at which phase cancellation between direct and the remaining reflected signals occurs, the substitution antenna shall be moved through a distance of ±0,1 m in the direction of the test antenna as well as in the two directions perpendicular to this first direction.

If these changes of distance cause a signal change of greater than 2 dB, the test sample should be re-sited until a change of less than 2 dB is obtained.

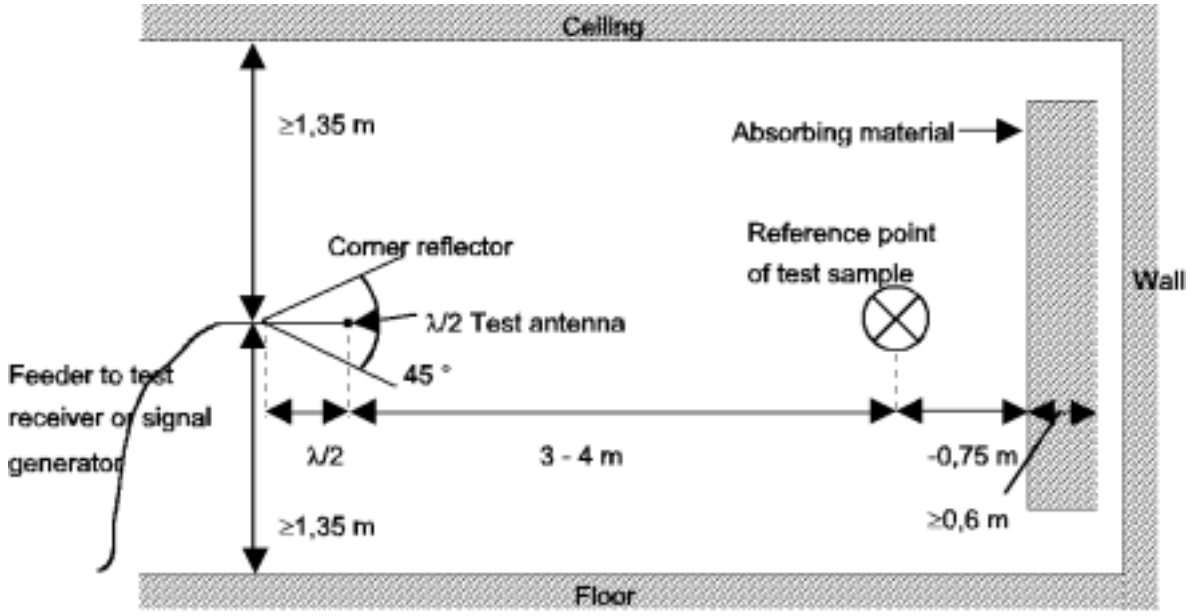


Figure B.2: Indoor site arrangement (shown for horizontal polarization)

B.2 Guidance on the use of radiation test sites

For measurements involving the use of radiated fields, use may be made of a test site in conformity with the requirements of clause B.1 of this annex. When using such a test site, the following conditions should be observed to ensure consistency of measuring results.

B.2.1 Measuring distance

Evidence indicates that the measuring distance is not critical and does not significantly affect the measuring results, provided that the distance is not less than lambda/2 at the frequency of measurement, and the precautions described in this annex are observed. Measuring distances of 3 m, 5 m, 10 m and 30 m are in common use in European test laboratories.

B.2.2 Test antenna

Different types of test antenna may be used, since performing substitution measurements reduces the effect of the errors on the measuring results.

Height variation of the test antenna over a range of 1 m to 4 m is essential in order to find the point at which the radiation is a maximum.

Height variation of the test antenna may not be necessary at the lower frequencies below about 100 MHz.

B.2.3 Substitution antenna

Variations in the measuring results may occur with the use of different types of substitution antenna at the lower frequencies below about 80 MHz.

Where a shortened dipole antenna is used at these frequencies, details of the type of antenna used should be included with the results of the tests carried out on the site. Correction factors shall be taken into account when shortened dipole antennas are used.

B.2.4 Artificial antenna

The dimensions of the artificial antenna used during radiated measurements should be small in relation to the sample under test.

Where possible, a direct connection should be used between the artificial antenna and the test sample.

In cases where it is necessary to use a connecting cable, precautions should be taken to reduce the radiation from this cable by, for example, the use of ferrite cores or double screened cables.

B.2.5 Auxiliary cables

The position of auxiliary cables (power supply and microphone cables etc.) which are not adequately decoupled may cause variations in the measuring results. In order to get reproducible results, cables and wires of auxiliaries should be arranged vertically downwards (through a hole in the non conducting support).

B.2.6 Acoustic measuring arrangement

When carrying out measurements of the maximum usable sensitivity (radiated) of the receiver, the audio output shall be monitored by acoustically coupling the audio signal from the receiver loudspeaker/transducer to the test microphone. On the radiation test site all conducting materials shall be placed below the ground surface and the acoustic signal is conveyed from the receiver to the test microphone in a non-conducting acoustic pipe.

The acoustic pipe shall have an appropriate length. The acoustic pipe shall have an inner diameter of 6 mm and a wall thickness of 1,5 mm. A plastic funnel of a diameter corresponding to the receiver loudspeaker/transducer shall be attached to the receiver surface centred in front of the receiver loudspeaker/transducer. The plastic funnel shall be very soft at the attachment point to the receiver in order to avoid mechanical resonance. The narrow end of the plastic funnel shall be connected to the one end of the acoustic pipe and the test microphone to the other.

B.3 Further optional alternative indoor test site using an anechoic chamber

For radiation measurements when the frequency of the signals being measured is greater than 30 MHz, use may be made of an indoor site being a well-shielded anechoic chamber simulating free space environment. If such a chamber is used, this shall be recorded in the test report.

The test antenna, measuring receiver, substitution antenna and calibrated signal generator are used in a way similar to that of the general method, clause B.1. In the range between 30 MHz and 100 MHz some additional calibration may be necessary.

An example of a typical measurement site may be an electrically shielded anechoic chamber being 10 m long, 5 m broad and 5 m high.

Walls and ceiling should be coated with RF absorbers of 1 m height.

The base should be covered with absorbing material 1 m thick, and a wooden floor, able to carry test equipment and operators.

A measuring distance of 3 m to 5 m in the long middle axis of the chamber can be used for measurements up to 12,75 GHz.

The construction of the anechoic chamber is described in the following clauses.

B.3.1 Example of the construction of a shielded anechoic chamber

Free-field measurements can be simulated in a shielded measuring chamber where the walls are coated with RF absorbers.

Figure B.3 shows the requirements for shielding loss and wall return loss of such a room.

As dimensions and characteristics of usual absorber materials are critical below 100 MHz (height of absorbers < 1 m, reflection attenuation < 20 dB) such a room is preferably suitable for measurements above 100 MHz.

Figure B.4 shows the construction of a shielded measuring chamber having a base area of 5 m by 10 m and a height of 5 m.

Ceilings and walls are coated with pyramidal formed absorbers approximately 1 m high. The base is covered with absorbers which are able to carry and which forms a sort of floor.

The available internal dimensions of the room are 3 m x 8 m x 3 m, so that a measuring distance of maximum 5 m length in the middle axis of this room is available.

At 100 MHz the measuring distance can be extended up to a maximum of 2 lambda.

The floor absorbers reject floor reflections so that the antenna height need not be changed and floor reflection influences need not be considered.

All measuring results can therefore be checked with simple calculations and the measuring tolerances have the smallest possible values due to the simple measuring configuration.

For special measurements it can be necessary to re-introduce floor reflections. Taking away the floor absorbers would mean a removal of approximately 24 m^3 absorber material. Therefore the floor absorbers are covered with metal plates of metallic nets instead.

B.3.2 Influence of parasitic reflections in anechoic chambers

For free-space propagation in the far field condition the correlation E = Eo(Ro/R) is valid for the dependence of the field strength E on the distance R, whereby Eo is the reference field strength in the reference distance Ro.

It is useful to use just this correlation for comparison measurements, as all constants are eliminated with the ratio and neither cable attenuation nor antenna mismatch or antenna dimensions are of importance.

Deviations from the ideal curve can be seen easily if the logarithm of the above equation is used, because the ideal correlation of field strength and distance can then be shown as a straight line and the deviations occurring in practice are clearly visible. This indirect method shows the disturbances due to reflections more readily and is far less problematical than the direct measurement of reflection attenuation.

With an anechoic chamber of the dimensions suggested in clause B.3 at low frequencies up to 100 MHz there are no far field conditions, and therefore reflections are stronger so that careful calibration is necessary.

In the medium frequency range from 100 MHz to 1 GHz the dependence of the field strength on the distance meets the expectations very well.

In the frequency range of 1 GHz to 12,75 GHz, because more reflections will occur, the dependence of the field strength on the distance will not correlate so closely.

B.3.3 Calibration of the shielded anechoic chamber

Careful calibration of the chamber shall be performed over the range 30 MHz to 12,75 GHz.

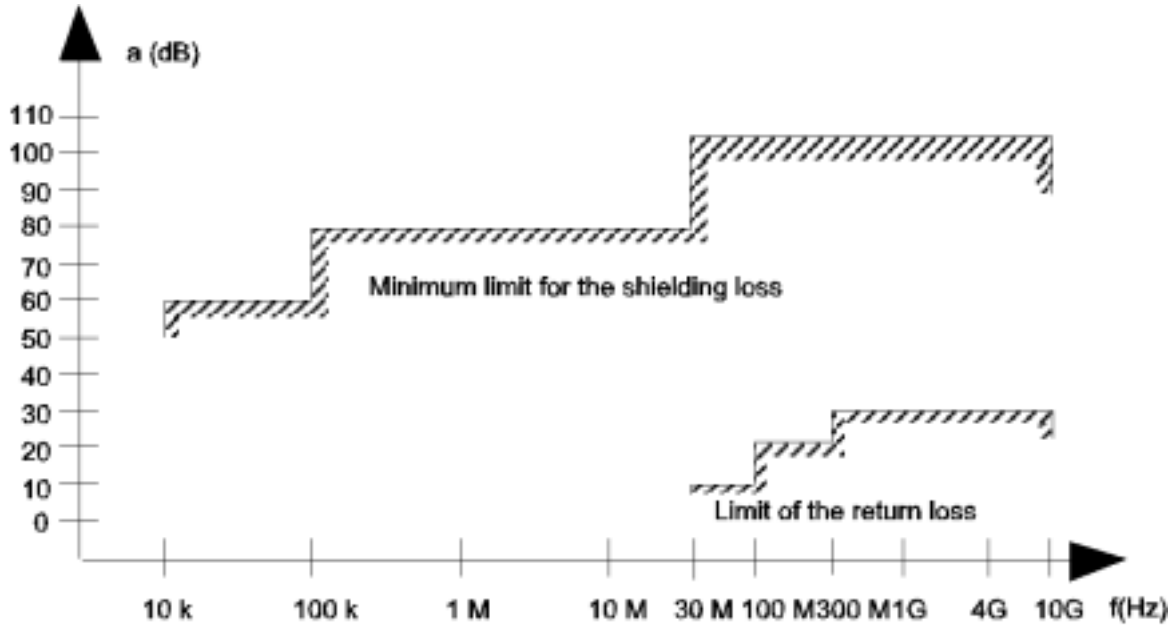
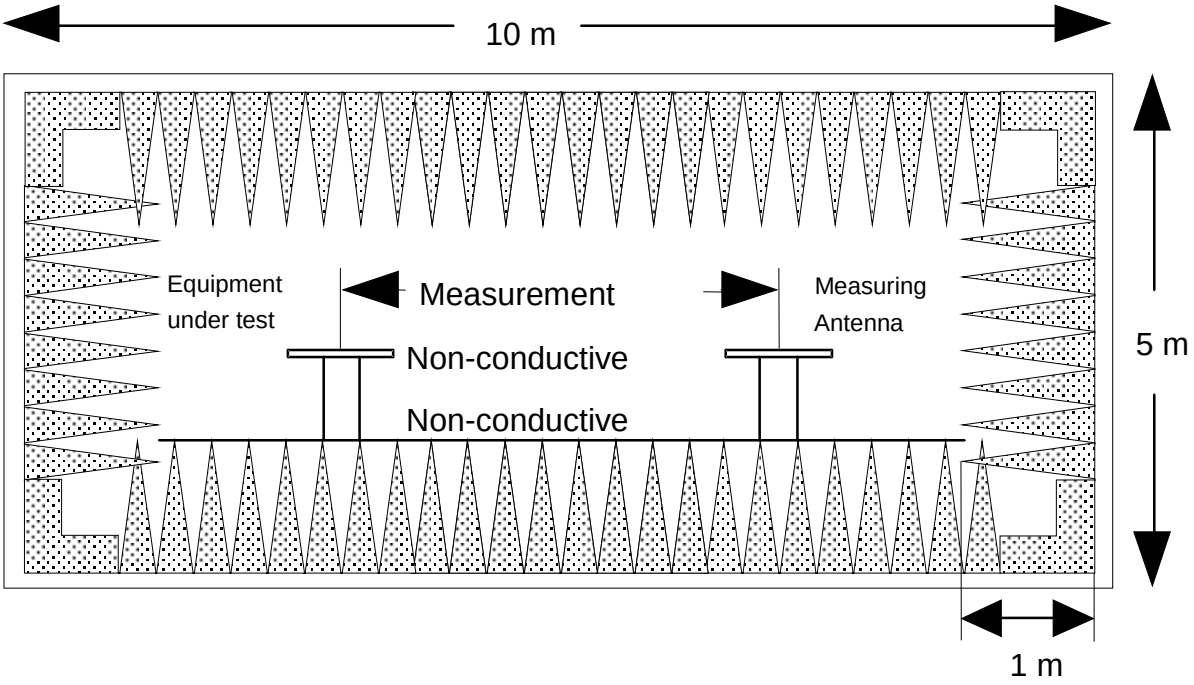


Figure B.3: Specifications for shielding and reflections



Ground plan

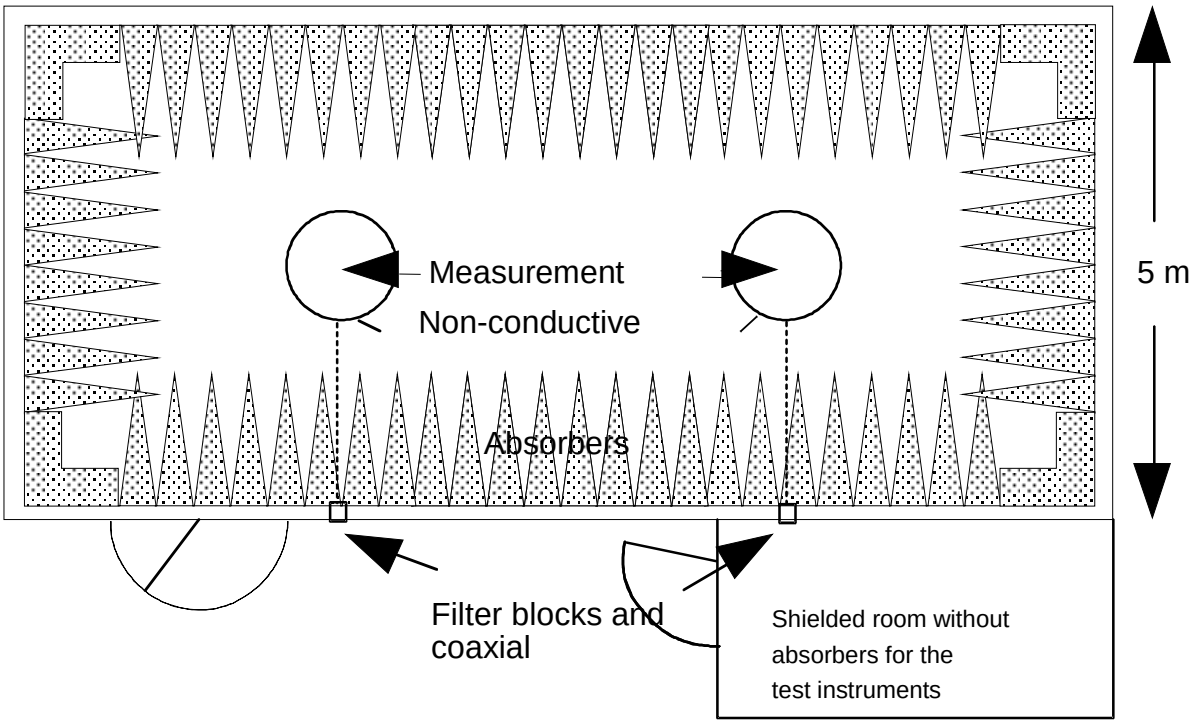


Figure B.4: Example of construction of an anechoic shielded chamber

Annex C (informative): Bibliography

- ITU-R Recommendation 332-4: "Selectivity of receivers".
- ITU-R Recommendation 326-6: "Determination and measurement of the power of radio transmitters".
- ETS 300 019-1-6: "Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-6: Classification of environmental conditions: Ship environments".

History

Document history			
V1.2.1	December 2001	Public Enquiry	PE 20020405: 2001-12-05 to 2002-04-05