

**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**



Reference

REN/ERM-TG26-081-1

Keywords

maritime, radio, telephony

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Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

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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 Vote 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; Equipment with integrated or associated equipment for Class E Digital Selective Calling (DSC)".

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.

Notes to V1.3.1:

The spurious emissions test in V1.2.1 was just the EMC emissions test from CENELEC EN 60945 [i.11]. It was not specified whether to perform the test in receive or transmit mode and further, there was no modulation specified for the SSB transmitter.

Spurious emissions measurements are now aligned with definitions and limits related to CEPT/ERO Rec 74-01 [i.12].

Spurious emission limits are now the same for conducted and radiated in line with other radio standards.

The EMC tests have been removed as these are all covered by EN 301 843-5 [i.5] which specifies limits taken from CENELEC EN 60945 [i.11] appropriate for both R&TTE [i.13] and MED [i.14] directives.

Maritime environmental tests are still contained in the present document.

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 [i.6], to the Maritime Mobile Service (MMS).

The present document includes the International Maritime Organization (IMO) and ITU requirements included in the relevant provisions of the Radio Regulations [i.6], the International Convention for the Safety Of Life At Sea (SOLAS) [i.1], the IMO Resolutions A.694(17) [i.3] and A806 (19) [i.2] 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 [i.14].

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.493-13 [i.4].

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 1: The requirements for integrated equipment may be found in other relevant ENs.

NOTE 2: The requirements for other modes of operation may be found in other relevant ENs.

The tests in the present document are applicable to equipment operating on all frequencies in the bands 1 606,5 kHz to 4 000 kHz or 1 606,5 kHz to 27,5 MHz as allocated in the Radio Regulations [i.6], to the MMS.

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.

NOTE 3: The EMC requirements for this type of equipment are found in EN 301 843-5 [i.5].

2 References

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

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

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

2.1 Normative references

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

- [1] Void.
- [2] ITU-T Recommendation E.161 (2001): "Arrangement of digits, letters and symbols on telephones and other devices that can be used for gaining access to a telephone network".
- [3] CENELEC EN 61162-1 (2007): "Maritime navigation and radiocommunication equipment and systems - Digital interfaces - Part 1: Single talker and multiple listeners".
- [4] ISO 3791: "Office machines and data processing equipment - Keyboard layouts for numeric applications".

- [5] ETSI TR 100 028 (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".
- [6] Void.
- [7] ANSI C63.5-2006: "American National Standard for Calibration of Antennas Used for Radiated Emission Measurements in Electro Magnetic Interference".
- [8] IEC 60489-3 Second edition (1999) appendix F: "Methods of measurement for radio equipment used in the mobile services. Part 3: Receivers for A3E or F3E emissions".

2.2 Informative references

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

- [i.1] International Convention for the Safety of Life at Sea, (SOLAS), as amended.
- [i.2] IMO Resolutions A.806(19): "Performance Standards for Shipborne MF/HF Radio Installations Capable of Voice Communication, Narrow-Band Direct Printing and Digital Selective Calling".
- [i.3] IMO Resolutions A.694(17): "General Requirements for Shipborne Radio Equipment Forming Part of the Global Maritime Distress and Safety System and for Electronic Navigational Aids".
- [i.4] ITU-R Recommendation M.493-13 (2009): "Digital selective-calling system for use in the maritime mobile service".
- [i.5] ETSI EN 301 843-5: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for marine radio equipment and services; Part 5: Specific conditions for MF/HF radiotelephone transmitters and receivers".
- [i.6] ITU Radio Regulations (2008).
- [i.7] ETSI 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".
- [i.8] ITU-R Recommendation SM.326-6: "Determination and measurement of the power of radio transmitters".
- [i.9] ITU-R Recommendation SM.332-4: "Selectivity of receivers".
- [i.10] ETSI TR 102 273 (parts 2, 3 and 4): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Improvement on Radiated Methods of Measurement (using test site) and evaluation of the corresponding measurement uncertainties".
- [i.11] CENELEC EN 60945: "Maritime navigation and radiocommunication equipment and systems - General requirements - Methods of testing and required test results".
- [i.12] ECPT/ERO Rec 74-01: "Unwanted Emissions in the Spurious Domain".
- [i.13] Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity (R&TTE Directive).
- [i.14] Council Directive 96/98/EC of 20 December 1996 on marine equipment (Marine Equipment Directive).

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 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

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 (see ITU Radio Regulations)

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.

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).

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

3.2 Symbols

For the purposes of the present document, the following symbols apply as defined in the Radio Regulations [1.6]:

dBA	dB relative to 2×10^{-5} Pascal
dBd	antenna gain relative to a half-wave dipole
dB μ V	dB relative to 1 microvolt emf
dB μ V/m	dB relative to 1 microvolt per metre

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
NaCl	sodium chloride

3.3 Abbreviations

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

AC	Alternating Current
AGC	Automatic Gain Control
Bd	Baud
BER	Bit Error Rate
CSP	Channel SPacing
DC	Direct Current
DSC	Digital Selective Calling
EE	Equipment Engineering
EMC	ElectroMagnetic Compatibility
emf	electromotive force
EUT	Equipment Under Test
FSI	Frequency Set Information
FSK	Frequency Shift Keying
IF	Intermediate Frequency
IMO	International Maritime Organization
ISO	International Standards Organization
ITU	International Telecommunications Union
MF	Medium Frequency
MF/HF	Medium and High Frequency
MMS	Maritime Mobile Service
NBDP	Narrow Band Direct Printing telegraphy
OATS	Open Area Test Site
RF	Radio Frequency
RMS	Root Mean Square
SINAD	Signal + Noise + Distortion / Noise + Distortion
SNR	Signal-to-Noise Ratio
SOLAS	Safety Of Life At Sea
sr	switching range
SSB	Single SideBand
USB	Upper SideBand
VSWR	Voltage Standing Wave Ratio

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 k Ω .

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 to 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 to ISO 3791 [4].

4.1.6 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.
- Connectors used should be readily available commercially. Manufacturers shall provide identification of the actual connections used.

4.1.6.1 Audio frequency interfaces

a) transmitters:

- SSB Telephony:
 - 600 Ω earth free audio input;
 - microphone input.
- DSC with analogue interfaces:
 - 600 Ω earth free audio input.

b) receivers:

- SSB Telephony:
 - 600 Ω earth free audio output;
 - earphone output;
 - speaker output.

- DSC with analogue interfaces:
 - 600 Ω earth free audio output.

4.1.6.2 Digital interfaces

- a) DSC with digital interfaces:

EN 61162-1 [3] input.

The logic level and the appropriate functions shall comply with EN 61162-1 [3]. The B-state shall be logic "0", and the Y-state shall be logic "1".

- b) control interface:

The interface for control shall comply with EN 61162-1 [3].

The control protocol shall include Frequency Set Information (FSI) (see annex C).

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.

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.

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

4.6.1 Requirement

The equipment shall be capable of operating in either the MF or in the MF/HF bands as defined in clauses 4.6.2 and 4.6.3.

4.6.2 MF band

The equipment shall provide for the transmission and/or reception in the appropriate frequency bands between 1 606,5 kHz and 4 000 kHz allocated in the ITU Radio Regulations [i.6] to the MMS.

4.6.3 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 ITU Radio Regulations [i.6] 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 min 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 \pm 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 $\pm 10\%$.

The frequency of the test power supply corresponding to the ac mains shall be $50\text{ Hz} \pm 1\text{ Hz}$.

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 1 606,5 kHz to 4 000 kHz:
 - the artificial antenna shall consist of a resistance of $10\ \Omega$ and a capacitance of 250 pF connected in series;
- frequency range 4 MHz to 27,5 MHz:
 - the artificial antenna shall consist of a resistance of $50\ \Omega$.

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 $50\ \Omega$ except as permitted below:
 - in the frequency range 1 606,5 kHz to 4 000 kHz at the request of the manufacturer, an artificial antenna consisting of a $10\ \Omega$ 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 ($\pm 0,1$ 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.

5.6.4 Exclusion bands for emissions testing

5.6.4.1 Receiver exclusion bands

None applicable.

5.6.4.2 Transmitter exclusion bands

Frequencies ± 12 kHz of the assigned frequency shall be excluded from test.

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

5.6.5 Reference bandwidths for spurious measurements

The reference bandwidths applicable for all spurious measurement are given in table 2.

Table 2: Reference bandwidths to be used for the measurement of spurious emissions

Frequency range	RBW
9 kHz to 150 kHz	1 kHz
150 kHz to 30 MHz	10 kHz
30 MHz to 1 GHz	100 kHz
Above 1 GHz	1 MHz

5.7 Measurement uncertainty and interpretation of the measuring results

5.7.1 Measurement uncertainty

Table 3: Maximum measurement uncertainty

Parameter	Maximum value of measurement uncertainty
RF frequency	$\pm 1 \times 10^{-8}$
RF Power, PEP in 50 Ω	$\pm 1,5$ dB
RF Power, PEP in 10 Ω / 250 pF	$\pm 2,5$ dB
Conducted spurious emissions of transmitter	± 4 dB
Radiated spurious emissions	± 6 dB
Audio output power	$\pm 0,5$ dB
Sensitivity of receiver	± 3 dB
Conducted emission of receiver	± 3 dB
Two signal measurement	± 4 dB
Three signal measurement	± 3 dB

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 value of the measurement uncertainty for the measurement of each parameter shall be included in the test report;
- the recorded value of the measurement uncertainty shall be, for each measurement, equal to or lower than the figures in table 3.

For the test methods, according to the present document, the measurement uncertainty figures shall be calculated in accordance with TR 100 028 [5] and shall correspond to an expansion factor (coverage factor) $k = 1,96$ or $k = 2$ (which provide confidence levels of respectively 95 % and 95,45 % in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian)).

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.

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 [i.7].

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 \pm 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 \pm 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 9.1.1). The level of the input signal shall be not greater than +22 dB μ V at 2 182 kHz or not greater than +17 dB μ V 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 Hz 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 5.4 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 5.4 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 5.4 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 ($\pm 0,5$ 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, whichever is longer, before the next test is carried out.

7.5.3.2 Requirement

The limits under extreme conditions specified in clause 5.4 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, whichever is longer, before the next test is carried out.

7.5.4.1.2 Requirement

The limits under extreme conditions specified in clause 5.4 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, whichever 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 5.4 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 g \pm 10 %;
- magnesium chloride 2,50 g \pm 10 %;
- magnesium sulphate 3,50 g \pm 10 %;
- calcium chloride 1,10 g \pm 10 %;
- potassium chloride 0,73 g \pm 10 %;
- sodium bicarbonate 0,20 g \pm 10 %;
- sodium bromide 0,28 g \pm 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 % (\pm 1 %) by weight.

The solution shall be prepared by dissolving, by weight, 5 parts \pm 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 (\pm 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 5.3 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 m above the nozzle;
- test duration: 30 min;
- distance from the nozzle to the equipment surface: approximately 3 m.

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 5.3 shall be fulfilled.

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

8 Transmitter

8.1 General

8.1.1 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.

8.1.2 Class of emission

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

8.1.3 Minimum number of operating frequencies

8.1.3.1 Transmitters operating between 1 606,5 kHz to 4 000 kHz only

The transmitter shall have facilities for operation on all frequencies in the bands allocated in the ITU Radio Regulations [i.6], to the MMS.

8.1.3.2 Transmitters operating between 1 606,5 kHz to 27 500 kHz

The transmitter shall have facilities for operation on all frequencies in the bands allocated in the ITU Radio Regulations [i.6], to the MMS.

8.2 Frequency error

8.2.1 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.

8.2.2 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 $1\,000\text{ Hz} \pm 0,1\text{ Hz}$. The $1\,000\text{ Hz}$ 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 $1\,700\text{ Hz} \pm 0,1\text{ Hz}$.
- c) DSC with a digital interface:
 - the digital input shall first be connected to a digital 0 and then to a digital 1.

8.2.3 Limits

The transmitter frequencies shall, after the warming-up period specified in clause 4.7 be within $\pm 10\text{ Hz}$ of the frequencies calculated in accordance with the definitions in clause 8.2.1.

8.3 Output power and intermodulation products

8.3.1 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 SM.326-6 [i.8].

8.3.2 Method of measurement

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

Operating frequencies shall be $2\,182\text{ kHz}$ and each of the distress frequencies in bands 4 MHz , 6 MHz , 8 MHz , 12 MHz , 16 MHz and on one frequency in the highest band of operation as appropriate to the equipment.

- 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 $1\,100\text{ Hz}$ and $1\,700\text{ Hz}$. 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 $\pm 1,5\text{ dB}$. 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 $600\ \Omega$ 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 (see clause 5.3) and extreme test conditions (see clauses 5.4.1 and 5.4.2 applied simultaneously).

8.3.3 Limits

8.3.3.1 Output power in the range 1 606,5 kHz to 4 000 kHz for all modulation modes

The maximum peak envelope power or maximum mean power, as appropriate (see clause 8.3.1), shall be within $\pm 1,5$ dB of the manufacturer's declared value(s), shall be greater than 60 W and shall not exceed 400 W.

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

The maximum peak envelope power or maximum mean power, as appropriate (see clause 8.3.1), shall be within $\pm 1,5$ dB of the manufacturer's declared value(s), shall be greater than 60 W, and shall not exceed 1 500 W.

8.3.3.3 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.

8.3.3.4 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.

8.3.3.5 Output spectrum

The output spectrum on DSC sending a dot pattern shall fall within the mask defined in figure 1.

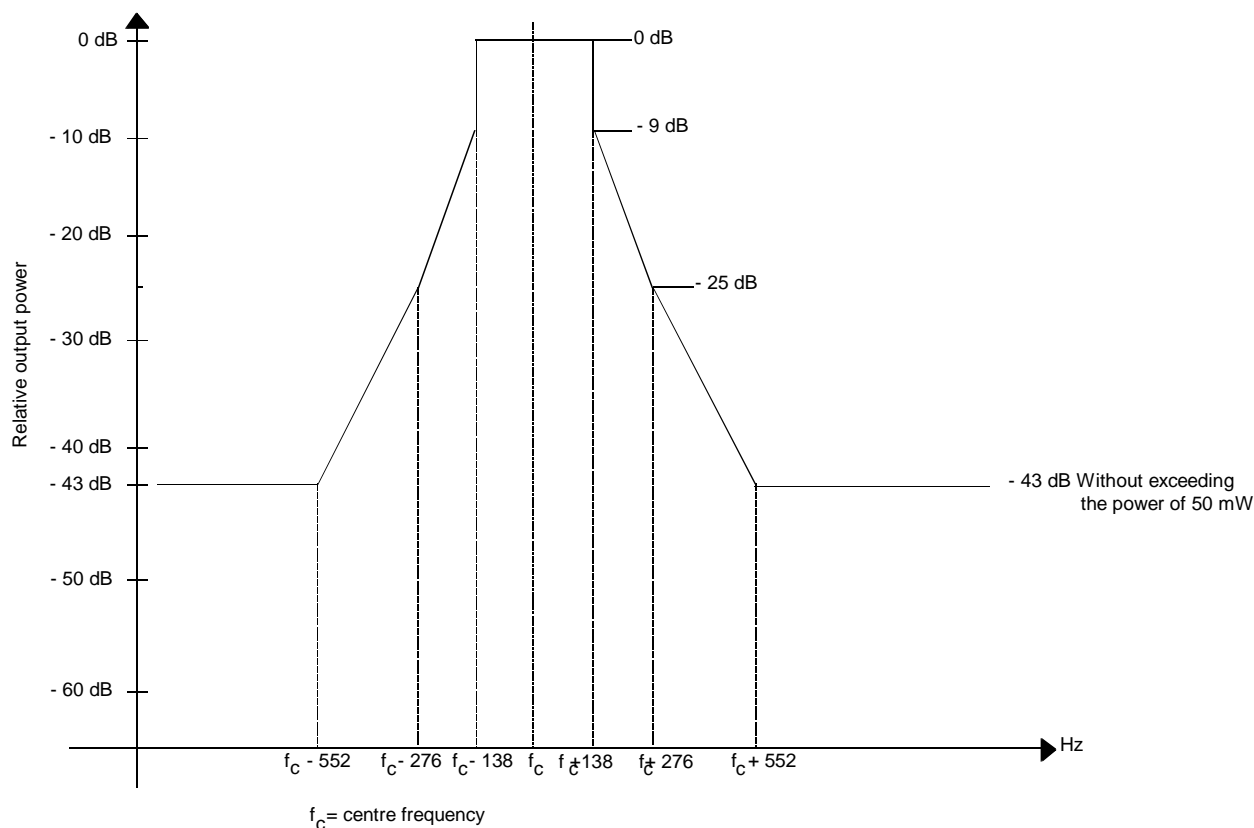


Figure 1: Limits

8.4 Unwanted frequency modulation

8.4.1 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.

8.4.2 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 8.3.

The transmitter shall be subject to the vibration test sequence described in clause 7.4.1.

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 7.4.

The test shall be performed on 2 182 kHz if the transmitter is designed to work in the 1 606,5 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 1 606,5 kHz to 27 500 kHz range.

8.4.3 Limits

The frequency peak deviation shall not exceed ± 5 Hz.

8.5 Sensitivity of the microphone

8.5.1 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.

8.5.2 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.

8.5.3 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.

8.6 Sensitivity of the 600 Ω line input for SSB telephony

8.6.1 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.

8.6.2 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.

8.6.3 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.

8.7 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.

8.7.1 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 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 8.3, 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 2 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.

8.7.2 Limits

The graph shall lie within the limits given in figure 2.

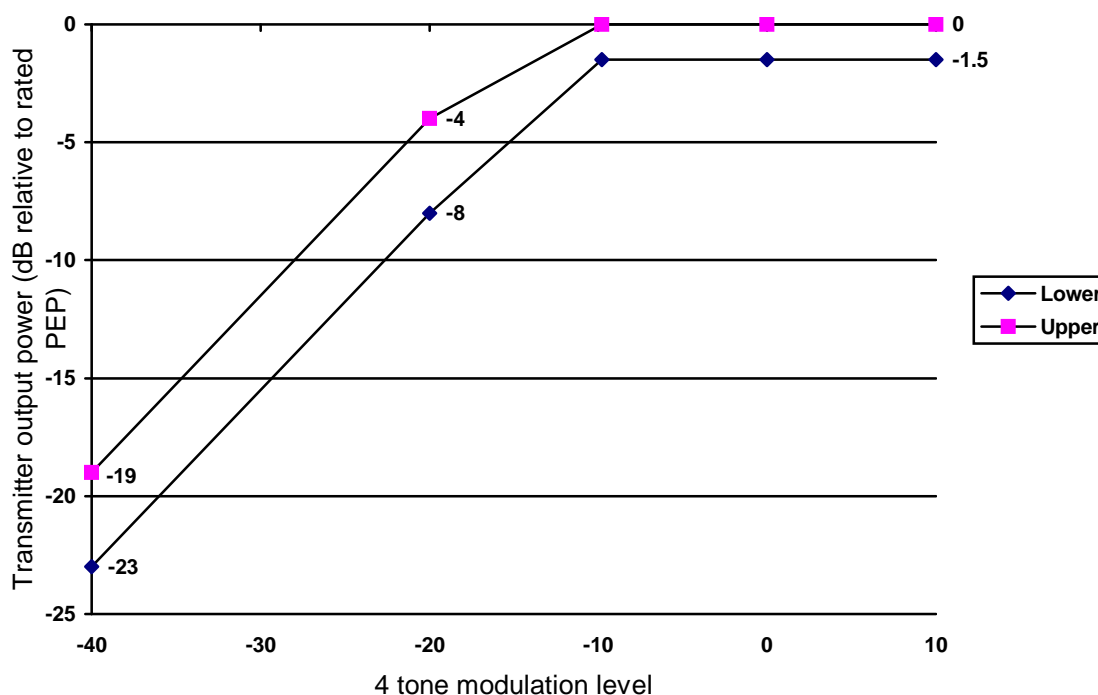


Figure 2: Limits of telephony level control

8.8 Audio frequency response of SSB telephony

8.8.1 Definition

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

8.8.2 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).

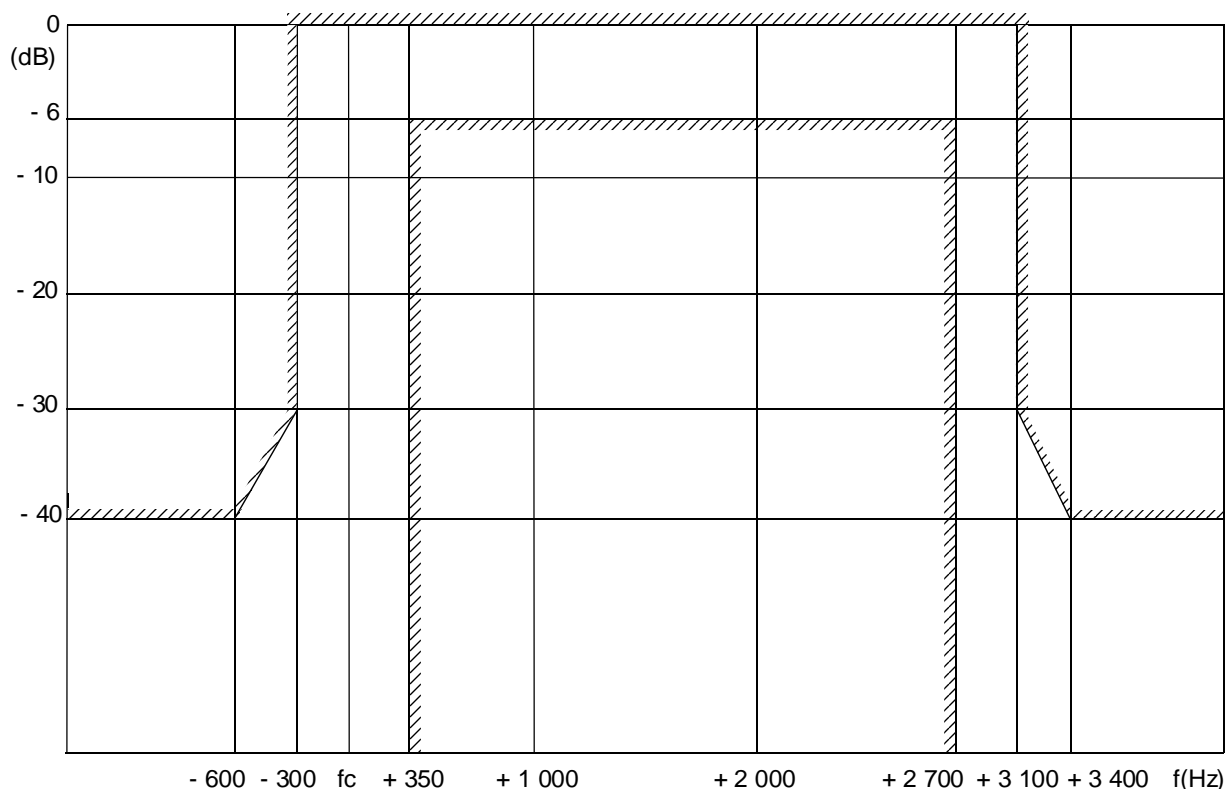
The level of the test signal shall be adjusted so that the output power at the peak of the response characteristic is 10 dB below the rated output power.

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

8.8.3 Limits

The graph shown in figure 3 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 3.



Audio frequency response

Figure 3: Limits of audio frequency response

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

8.9.1 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.

8.9.2 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 8.3 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.

8.9.3 Limits

The power of any out-of-band emission supplied to the artificial antenna shall be in accordance with the limits given in table 4.

Table 4: 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
$1,5 < \Delta \pm 4,5$	31 dB
$4,5 < \Delta \pm 7,5$	38 dB
$7,5 < \Delta \pm 12$	43 dB without exceeding the power of 50 mW

8.10 Power of conducted spurious emissions of SSB telephony

8.10.1 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.

8.10.2 Method of measurement

Spurious emissions shall be measured as the mean power level of any signal delivered into a 50 Ω load. This may be done by connecting the transmitter output through an attenuator to either a spectrum analyser (see annex B) or selective voltmeter or by monitoring the relative levels of the spurious signals delivered to an artificial antenna (see clause 5.5.1).

The transmitter shall be modulated with the same test signal as used in clause 8.3 and the measurements made over the frequency range 9 kHz to 4 GHz.

The measurements are performed excluding the transmit exclusion band centred on the frequency on which the transmitter is intended to operate (see clause 5.6.4).

The resolution bandwidth of the measuring receiver should be equal to the reference bandwidth as given in clause 5.6.5.

The measurement shall be repeated with the transmitter in the "stand-by" position.

8.10.3 Limits

The power of any conducted spurious emission at the antenna port shall be in accordance with table 5.

Table 5: 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

8.11 Residual hum and noise power for telephony

8.11.1 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.

8.11.2 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 8.3.

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.

8.11.3 Limits

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

8.12 Residual frequency modulation on DSC

8.12.1 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.

8.12.2 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 8.3.

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.

8.12.3 Limits

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

8.13 Carrier suppression

8.13.1 Definition

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

8.13.2 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 8.3.

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).

8.13.3 Limits

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

8.14 Continuous operation on telephony

8.14.1 Definition

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

8.14.2 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 8.3 using the two-tone test signal as described in clause 8.3.2. 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).

8.14.3 Limits

The output power shall not vary by more than $\pm 1,5$ dB from the rated output power. The limits of clause 8.3.3 shall not be exceeded.

8.15 Protection of transmitter

8.15.1 Definition

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

8.15.2 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.

8.15.3 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.

8.16 Power of radiated spurious emissions

8.16.1 Definition

Spurious emissions are emissions 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. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products but exclude out of band emissions.

8.16.2 Method of measurement

On a test site, selected from annex A, the equipment shall be placed at the specified height on a non-conducting support.

The transmitter antenna connector shall be connected to an artificial antenna (see clause 5.5).

The output of the test antenna shall be connected to a measuring receiver.

The test antenna shall be orientated for vertical polarization and the length of the test antenna shall be chosen to correspond to the instantaneous frequency of the measuring receiver.

The transmitter shall be modulated with same test signal as used in clause 8.3 and the measurements made over the frequency range 30 MHz to 2 GHz.

The measurements are performed excluding the transmit exclusion band centred on the frequency on which the transmitter is intended to operate (see clause 5.6.4.2).

The resolution bandwidth of the measuring receiver should be equal to the reference bandwidth as given in clause 5.6.5.

The transmitter shall be switched and the measuring receiver shall be tuned over the frequency range 30 MHz to 2 GHz. At each frequency at which a discrete spurious component is detected, the test antenna shall be raised and lowered through the specified range of heights until a maximum signal level is detected on the measuring receiver.

When a test site according to clause A.1.1 is used there is no need to vary the height of the antenna.

The transmitter shall then be rotated through 360° in the horizontal plane, until the maximum signal level is detected by the measuring receiver.

The measuring receiver shall measure the mean power and this power shall be noted. The horizontal and vertical orientation of the antenna shall also be noted.

The transmitter shall be replaced by a substitution antenna as defined in clause A.1.5.

The substitution antenna shall be orientated for vertical polarization and the length of the substitution antenna shall be adjusted to correspond to the frequency of the spurious component detected.

The substitution antenna shall be connected to a calibrated signal generator.

The frequency of the calibrated signal generator shall be set to the frequency of the spurious component detected.

The input attenuator setting of the measuring receiver shall be adjusted in order to increase the sensitivity of the measuring receiver, if necessary.

The test antenna shall be raised and lowered through the specified range of heights to ensure that the maximum signal is received.

When a test site according to clause A.1.1 is used there is no need to vary the height of the antenna.

The input signal to the substitution antenna shall be adjusted to the level that produced a level detected by the measuring receiver, that is equal to the level noted while the spurious component was measured, corrected for the change of input attenuator setting of the measuring receiver.

The input level to the substitution antenna shall be recorded as power level.

The measurement shall be repeated with the test antenna and the substitution antenna orientated for horizontal polarization.

The measure of the effective radiated power of the spurious components is the larger of the two power levels recorded for each spurious component at the input to the substitution antenna, corrected for the gain of the antenna if necessary.

The measurement shall be repeated with the transmitter in the "stand-by" position.

8.16.3 Limits

The power of any spurious emission, occurring outside the exclusion band centred on the frequency on which the transmitter is intended to operate, shall not exceed the values given in table 6 with the transmitter operating and table 7 with the transmitter in standby mode.

Table 6: Radiated spurious limits in transmit mode

Frequency range or operating mode	Test Limits	Remarks
30 MHz to 2 GHz	-43 dBc without exceeding the power of 50 mW	

Table 7: Radiated spurious limits in standby and receive mode

Frequency Range	Test Limits	Remarks
30 MHz to 2 GHz	-57 dBm	

Where limits are stated using dBc, the reference level is the maximum RF output PEP of the transmitter measured at the antenna port according to clause 8.3.

9 Receiver

9.1 Receiver output powers

9.1.1 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.

9.1.2 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 9.12.3.

9.2 Frequency error

9.2.1 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 5.6.2.2.

9.2.2 Method of measurement

- a) SSB telephony:
 - a standard input signal for J3E at a level of +60 dB μ V 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 dB μ V. 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).

9.2.3 Limits

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

9.3 Unwanted frequency modulation

9.3.1 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.

9.3.2 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 5.6.2.2 shall be applied to its input at a level of +60 dB μ V.

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 7.4.1.

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.

9.3.3 Limits

The frequency peak deviation shall not exceed ± 5 Hz.

9.4 Pass band

9.4.1 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.

9.4.2 Method of measurement

9.4.2.1 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 dB μ V. This stabilizes the gain of the receiver. The other test signal shall be at a level +50 dB μ V 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.

9.4.3 Limits

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

9.5 Maximum usable sensitivity

9.5.1 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.

9.5.2 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).

9.5.3 Limits

The maximum usable sensitivity shall be better than the values given in table 8.

Table 8: Limits of maximum usable sensitivity

Frequency range	Class of emission	Maximum level of input of input signal (dB μ V) 50 Ω or 10 Ω and 250 pF source impedance	
		Normal conditions	Extreme conditions
1 606,5 kHz to 4 000 kHz	J3E	+16	+22
	F1B	+5	+11
4 MHz to 27,5 MHz	J3E	+11	+17
	F1B	+0	+6

9.6 Adjacent signal selectivity

9.6.1 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 an increase of the bit error ratio to 10^{-2} .

9.6.2 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 is only required if the receiver does not have the J3E mode.

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

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

The wanted signal level shall be +20 dB μ V.

9.6.3 Limits

The adjacent signal selectivity shall exceed the values given in the tables 9, 10 and 11.

Table 9: 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 10: 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 11: 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

9.7 Blocking or desensitization

9.7.1 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.

9.7.2 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 dB μ V and repeated with the wanted signal at a level equal to the maximum usable sensitivity of the receiver as measured in replace 9.5.

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: Measurements 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 dB μ V.

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

9.7.3 Limits

Class of emission J3E or F1B (analogue output).

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

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.

9.8 Intermodulation response

9.8.1 Definition

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

9.8.2 Method of measurement

9.8.2.1 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 dB μ V 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 SM.332-4 [i.9], Section 6.4.

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.

9.8.2.2 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 dB μ V.

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 SM.332-4 [i.9], Section 6.4.

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.

9.8.2.3 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 dB μ V, 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 SM.332-4 [i.9], Section 6.4.

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.

9.8.3 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 dB μ V for J3E and +70 dB μ V 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 dB μ V.

9.9 Reciprocal mixing

9.9.1 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.

9.9.2 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 dB μ V. 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.

9.9.3 Results

The reciprocal mixing level shall be not less than +100 dB μ V.

9.10 Spurious response rejection ratio

9.10.1 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.

9.10.2 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 1 606,5 kHz and 4 000 kHz and 8 291 kHz for J3E receivers and 8 376,5 kHz for F1B receivers if the coverage is between 1 606,5 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:

$$n \times f_{lo1} \pm f_{if1}$$

$$p \times f_{receive} \pm f_{if1}$$

$$(f_{lo2} \pm f_{if2}) \pm f_{lo1}$$

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 and 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 replace 9.5. 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 8.

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 8.

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.

9.10.3 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.

9.11 Harmonic content in output

9.11.1 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.

9.11.2 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 dB μ V and +80 dB μ V, while maintaining the output level at the standard output power and then at the rated output power. The harmonic content shall then be measured.

9.11.3 Limits

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

9.12 Audio frequency intermodulation

9.12.1 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.

9.12.2 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 dB μ V 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 replace 9.1.1).

The audio frequency intermodulation components shall then be measured.

9.12.3 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.

9.13 Spurious emissions

9.13.1 Definition

Spurious emissions are emissions 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. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products but exclude out-of-band emissions.

9.13.2 Methods of measurement

Spurious emissions shall be measured as the mean power level of any signal delivered into a 50 Ω load. This may be done by connecting the transmitter output through an attenuator to either a spectrum analyser (see annex B) or selective voltmeter or by monitoring the relative levels of the spurious signals delivered to an artificial antenna (see clause 5.5.2).

The receiver shall be switched on and the measurements made over the frequency range 9 kHz to 4 GHz.

The resolution bandwidth of the measuring receiver should be equal to the reference bandwidth as given in clause 5.6.5.

9.13.3 Limits

The power of any discrete component measured into 50 Ω shall not exceed the values in table 12.

Table 12: Radiated spurious limits in receive mode

Frequency Range	Test Limits	Remarks
9 kHz to 2 GHz	-57 dBm	
2 GHz to 4 GHz	-47 dBm	

9.14 Internally generated spurious signals

9.14.1 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.

9.14.2 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.

9.14.3 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.

9.15 AGC efficiency

9.15.1 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.

9.15.2 Method of measurement and limits

9.15.2.1 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.

9.15.2.2 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 9.5. 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.

9.15.2.3 Range

Under the test conditions specified in clause 9.15.2.1 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.

9.16 AGC time constants (attack and recovery time)

9.16.1 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.

9.16.2 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.

9.16.3 Limits

Attack time: 5 ms to 10 ms;

Recovery Time: 1 s to 4 s.

9.17 Protection of input circuits

9.17.1 Definition

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

9.17.2 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 1 606,5 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 1 606,5 kHz to 27 500 kHz range.

9.17.3 Limit

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

9.18 Power of radiated spurious emissions

9.18.1 Definition

Spurious emissions are emissions 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. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products but exclude out of band emissions.

9.18.2 Method of measurement

On a test site, selected from annex A, the equipment shall be placed at the specified height on a non-conducting support.

The transmitter antenna connector shall be connected to an artificial antenna (see clause 5.5).

The output of the test antenna shall be connected to a measuring receiver.

The test antenna shall be orientated for vertical polarization and the length of the test antenna shall be chosen to correspond to the instantaneous frequency of the measuring receiver.

The resolution bandwidth of the measuring receiver should be equal to the reference bandwidth as given in clause 5.6.5.

The equipment shall be switched on in receive mode and the measuring receiver shall be tuned over the frequency range 30 MHz to 2 GHz. At each frequency at which a discrete spurious component is detected, the test antenna shall be raised and lowered through the specified range of heights until a maximum signal level is detected on the measuring receiver.

When a test site according to clause A.1.1 is used there is no need to vary the height of the antenna.

The equipment shall then be rotated through 360° in the horizontal plane, until the maximum signal level is detected by the measuring receiver.

The measuring receiver shall measure the mean power and this power shall be noted. The horizontal and vertical orientation of the antenna shall also be noted.

The equipment shall be replaced by a substitution antenna as defined in clause A.1.5.

The substitution antenna shall be orientated for vertical polarization and the length of the substitution antenna shall be adjusted to correspond to the frequency of the spurious component detected.

The substitution antenna shall be connected to a calibrated signal generator.

The frequency of the calibrated signal generator shall be set to the frequency of the spurious component detected.

The input attenuator setting of the measuring receiver shall be adjusted in order to increase the sensitivity of the measuring receiver, if necessary.

The test antenna shall be raised and lowered through the specified range of heights to ensure that the maximum signal is received.

When a test site according to clause A.1.1 is used there is no need to vary the height of the antenna.

The input signal to the substitution antenna shall be adjusted to the level that produced a level detected by the measuring receiver, that is equal to the level noted while the spurious component was measured, corrected for the change of input attenuator setting of the measuring receiver.

The input level to the substitution antenna shall be recorded as power level.

The measurement shall be repeated with the test antenna and the substitution antenna orientated for horizontal polarization.

The measure of the effective radiated power of the spurious components is the larger of the two power levels recorded for each spurious component at the input to the substitution antenna, corrected for the gain of the antenna if necessary.

The measurement shall be repeated with the transmitter in the "stand-by" position.

9.18.3 Limits

The power of any spurious emission in receive mode shall not exceed the values given in table 13.

Table 13: Radiated spurious limits in receive mode

Frequency Range	Test Limits	Remarks
30 MHz to 2 GHz	-57 dBm	

Annex A (normative): Radiated measurement

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

This normative annex introduces three most commonly available test sites, an anechoic chamber, an anechoic chamber with a ground plane and an Open Area Test Site (OATS), which may be used for radiated tests. These test sites are generally referred to as free field test sites. Both absolute and relative measurements can be performed in these sites. Where absolute measurements are to be carried out, the chamber should be verified. A detailed verification procedure is described in TR 102 273 [i.10], relevant parts 2, 3 and 4.

NOTE: To ensure reproducibility and traceability of radiated measurements only these test sites should be used in test measurements.

A.1.1 Anechoic chamber

An anechoic chamber is an enclosure, usually shielded, whose internal walls, floor and ceiling are covered with radio absorbing material, normally of the pyramidal urethane foam type. The chamber usually contains an antenna support at one end and a turntable at the other. A typical anechoic chamber is shown in figure A.1.

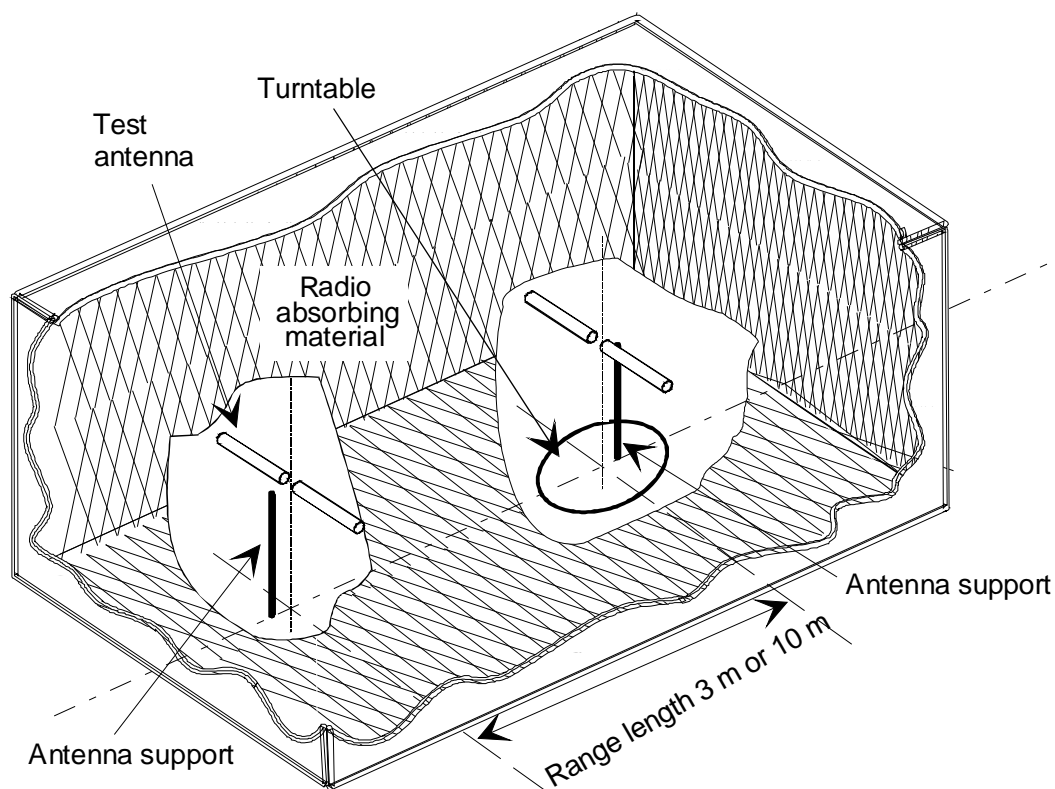


Figure A.1: A typical anechoic chamber

The chamber shielding and radio absorbing material work together to provide a controlled environment for testing purposes. This type of test chamber attempts to simulate free space conditions.

The shielding provides a test space, with reduced levels of interference from ambient signals and other outside effects, whilst the radio absorbing material minimizes unwanted reflections from the walls and ceiling which can influence the measurements. In practice it is relatively easy for shielding to provide high levels (80 dB to 140 dB) of ambient interference rejection, normally making ambient interference negligible.

A turntable is capable of rotation through 360° in the horizontal plane and it is used to support the test sample (EUT) at a suitable height (e.g. 1 m) above the ground plane. The chamber shall be large enough to allow the measuring distance of at least 3 m or $2(d_1+d_2)^2/\lambda$ (m), whichever is greater (see clause A.2.5). The distance used in actual measurements shall be recorded with the test results.

The anechoic chamber generally has several advantages over other test facilities. There is minimal ambient interference, minimal floor, ceiling and wall reflections and it is independent of the weather. It does however have some disadvantages which include limited measuring distance and limited lower frequency usage due to the size of the pyramidal absorbers. To improve low frequency performance, a combination structure of ferrite tiles and urethane foam absorbers is commonly used.

All types of emission, sensitivity and immunity testing can be carried out within an anechoic chamber without limitation.

A.1.2 Anechoic chamber with a ground plane

An anechoic chamber with a ground plane is an enclosure, usually shielded, whose internal walls and ceiling are covered with radio absorbing material, normally of the pyramidal urethane foam type. The floor, which is metallic, is not covered and forms the ground plane. The chamber usually contains an antenna mast at one end and a turntable at the other. A typical anechoic chamber with a ground plane is shown in figure A.2.

This type of test chamber attempts to simulate an ideal OATS whose primary characteristic is a perfectly conducting ground plane of infinite extent.

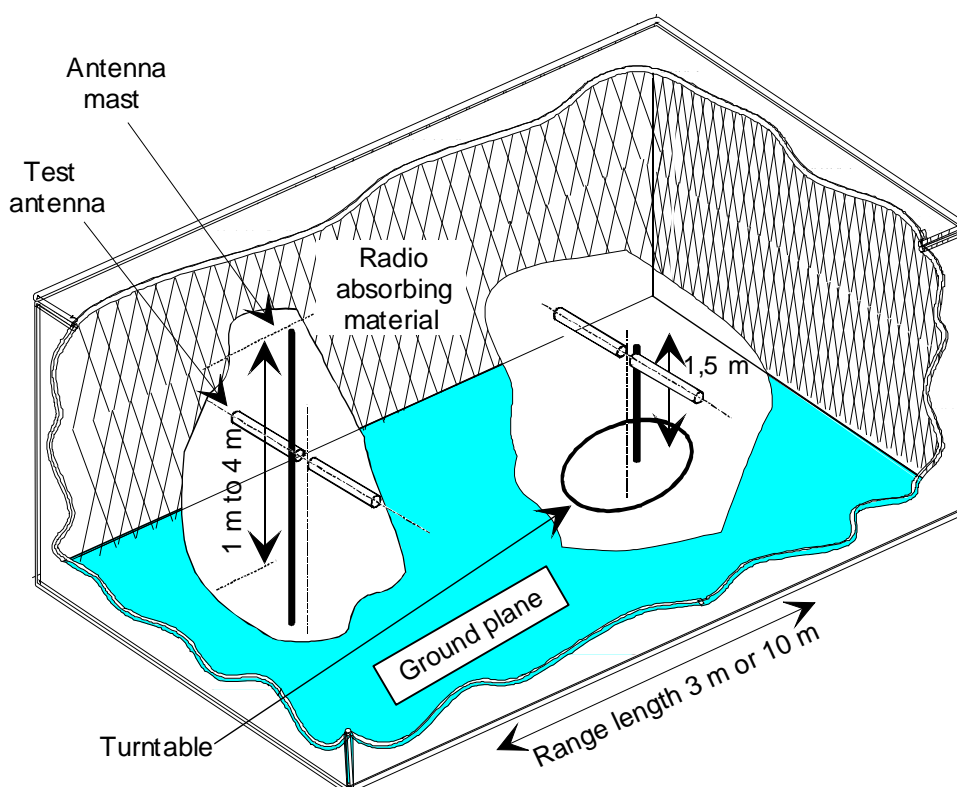


Figure A.2: A typical anechoic chamber with a ground plane

In this facility the ground plane creates the wanted reflection path, such that the signal received by the receiving antenna is the sum of the signals from both the direct and reflected transmission paths. This creates a unique received signal level for each height of the transmitting antenna (or EUT) and the receiving antenna above the ground plane.

The antenna mast provides a variable height facility (from 1 m to 4 m) so that the position of the test antenna can be optimized for maximum coupled signal between antennas or between an EUT and the test antenna.

A turntable is capable of rotation through 360° in the horizontal plane and it is used to support the test sample (EUT) at a specified height, usually 1,5 m above the ground plane. The chamber shall be large enough to allow the measuring distance of at least 3 m or $2(d_1+d_2)^2/\lambda$ (m), whichever is greater (see clause A.2.5). The distance used in actual measurements shall be recorded with the test results.

Emission testing involves firstly "peaking" the field strength from the EUT by raising and lowering the receiving antenna on the mast (to obtain the maximum constructive interference of the direct and reflected signals from the EUT) and then rotating the turntable for a "peak" in the azimuth plane. At this height of the test antenna on the mast, the amplitude of the received signal is noted. Secondly the EUT is replaced by a substitution antenna (positioned at the EUT's phase or volume centre) which is connected to a signal generator. The signal is again "peaked" and the signal generator output adjusted until the level, noted in stage one, is again measured on the receiving device.

Receiver sensitivity tests over a ground plane also involve "peaking" the field strength by raising and lowering the test antenna on the mast to obtain the maximum constructive interference of the direct and reflected signals, this time using a measuring antenna which has been positioned where the phase or volume centre of the EUT will be during testing. A transform factor is derived. The test antenna remains at the same height for stage two, during which the measuring antenna is replaced by the EUT. The amplitude of the transmitted signal is reduced to determine the field strength level at which a specified response is obtained from the EUT.

A.1.3 OATS

An OATS comprises a turntable at one end and an antenna mast of variable height at the other end above a ground plane which, in the ideal case, is perfectly conducting and of infinite extent. In practice, whilst good conductivity can be achieved, the ground plane size has to be limited. A typical OATS is shown in figure A.3.

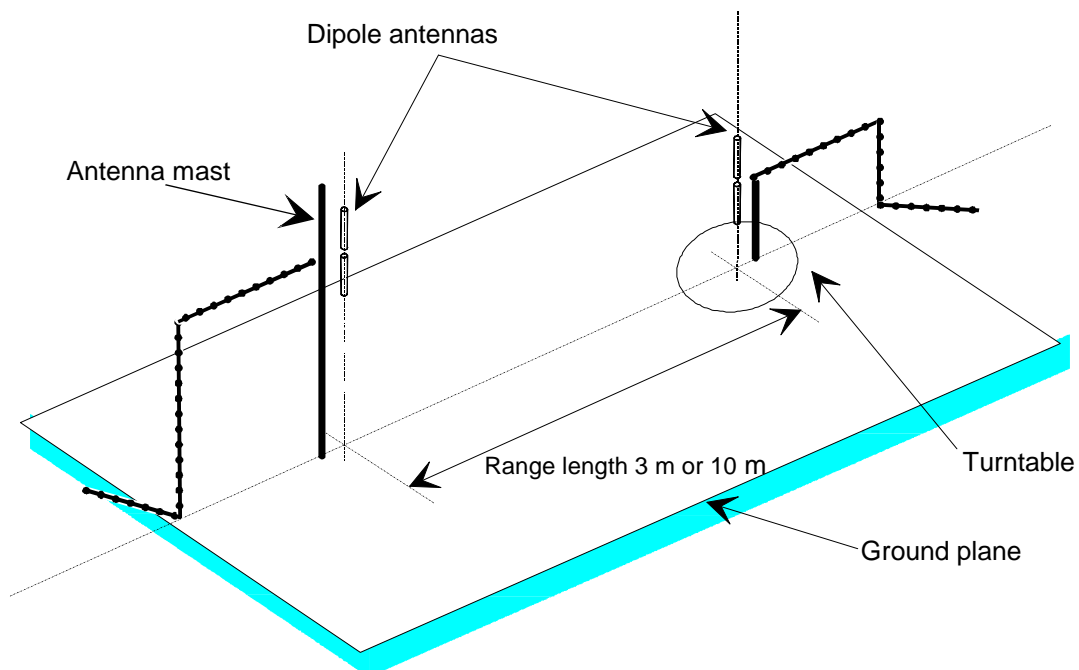


Figure A.3: A typical OATS

The ground plane creates a wanted reflection path, such that the signal received by the receiving antenna is the sum of the signals received from the direct and reflected transmission paths. The phasing of these two signals creates a unique received level for each height of the transmitting antenna (or EUT) and the receiving antenna above the ground plane.

Site qualification concerning antenna positions, turntable, measurement distance and other arrangements are same as for anechoic chamber with a ground plane. In radiated measurements an OATS is also used by the same way as anechoic chamber with a ground plane.

Typical measuring arrangement common for ground plane test sites is presented in figure A.4.

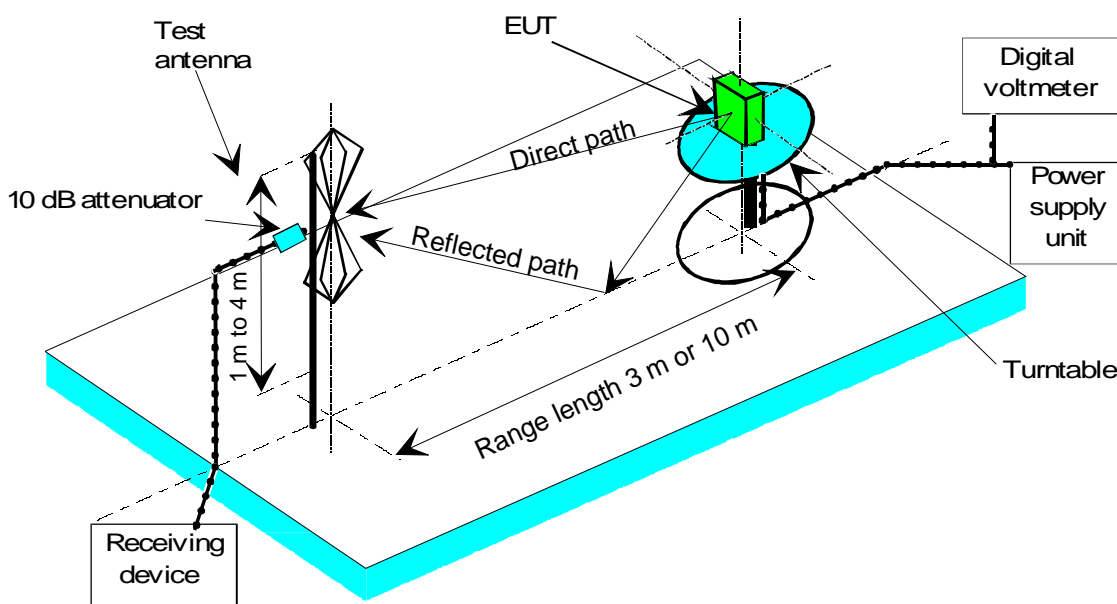


Figure A.4: Measuring arrangement on ground plane test site (OATS set-up for spurious emission testing)

A.1.4 Test antenna

A test antenna is always used in radiated test methods. In emission tests (i.e. frequency error, effective radiated power, spurious emissions and adjacent channel power) the test antenna is used to detect the field from the EUT in one stage of the measurement and from the substitution antenna in the other stage. When the test site is used for the measurement of receiver characteristics (i.e. sensitivity and various immunity parameters) the antenna is used as the transmitting device.

The test antenna should be mounted on a support capable of allowing the antenna to be used in either horizontal or vertical polarization which, on ground plane sites (i.e. anechoic chambers with ground planes and OATS), should additionally allow the height of its centre above the ground to be varied over the specified range (usually 1 m to 4 m).

In the frequency band 30 MHz to 1 000 MHz, dipole antennas (constructed in accordance with ANSI C63.5 [7]) are generally recommended. For frequencies of 80 MHz and above, the dipoles should have their arm lengths set for resonance at the frequency of test. Below 80 MHz, shortened arm lengths are recommended. For spurious emission testing, however, a combination of bicones and log periodic dipole array antennas (commonly termed "log periodics") could be used to cover the entire 30 MHz to 1 000 MHz band. Above 1 000 MHz, waveguide horns are recommended although, again, log periodics could be used.

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

A.1.5 Substitution antenna

The substitution antenna is used to replace the EUT for tests in which a transmitting parameter (i.e. frequency error, effective radiated power, spurious emissions and adjacent channel power) is being measured. For measurements in the frequency band 30 MHz to 1 000 MHz, the substitution antenna should be a dipole antenna (constructed in accordance with ANSI C63.5 [7]). For frequencies of 80 MHz and above, the dipoles should have their arm lengths set for resonance at the frequency of test. Below 80 MHz, shortened arm lengths are recommended. For measurements above 1 000 MHz, a waveguide horn is recommended. The centre of this antenna should coincide with either the phase centre or volume centre (as specified in the test method) of the EUT it has replaced.

A.1.6 Measuring antenna

The measuring antenna is used in tests on an EUT in which a receiving parameter (i.e. sensitivity and various immunity tests) is being measured. Its purpose is to enable a measurement of the electric field strength in the vicinity of the EUT. For measurements in the frequency band 30 MHz to 1 000 MHz, the measuring antenna should be a dipole antenna (constructed in accordance with ANSI C63.5 [7]). For frequencies of 80 MHz and above, the dipoles should have their arm lengths set for resonance at the frequency of test. Below 80 MHz, shortened arm lengths are recommended. The centre of this antenna should coincide with either the phase centre or volume centre (as specified in the test method) of the EUT.

A.2 Guidance on the use of radiation test sites

This clause details procedures, test equipment arrangements and verification that should be carried out before any of the radiated test are undertaken. These schemes are common to all types of test sites described in this annex.

A.2.1 Verification of the test site

No test should be carried out on a test site which does not possess a valid certificate of verification. The verification procedures for the different types of test sites described in this annex (i.e. anechoic chamber, anechoic chamber with a ground plane and OATS) are given in TR 102 273 [i.10], parts 2, 3 and 4, respectively.

A.2.2 Preparation of the EUT

The manufacturer should supply information about the EUT covering the operating frequency, polarization, supply voltage(s) and the reference face. Additional information, specific to the type of EUT should include, where relevant, carrier power, CSP, whether different operating modes are available (e.g. high and low power modes) and if operation is continuous or is subject to a maximum test duty cycle (e.g. 1 m on, 4 m off).

Where necessary, a mounting bracket of minimal size should be available for mounting the EUT on the turntable. This bracket should be made from low conductivity, low relative dielectric constant (i.e. less than 1,5) material(s) such as expanded polystyrene, balsa wood, etc.

A.2.3 Power supplies to the EUT

All tests should be performed using power supplies wherever possible, including tests on EUT designed for battery-only use. In all cases, power leads should be connected to the EUT's supply terminals (and monitored with a digital voltmeter) but the battery should remain present, electrically isolated from the rest of the equipment, possibly by putting tape over its contacts.

The presence of these power cables can, however, affect the measured performance of the EUT. For this reason, they should be made to be "transparent" as far as the testing is concerned. This can be achieved by routing them away from the EUT and down to the either the screen, ground plane or facility wall (as appropriate) by the shortest possible paths. Precautions should be taken to minimize pick-up on these leads (e.g. the leads could be twisted together, loaded with ferrite beads at 0,15 m spacing or otherwise loaded).

Details shall be included in the test report.

A.2.4 Volume control setting for analogue speech tests

Unless otherwise stated, in all receiver measurements for analogue speech the receiver volume control where possible, should be adjusted to give at least 50 % of the rated audio output power. In the case of stepped volume controls, to volume control should be set to the first step that provides an output power of at least 50 % of the rated audio output power. This control should not be readjusted between normal and extreme test conditions in tests.

A.2.5 Range length

The range length for all these types of test facility should be adequate to allow for testing in the far-field of the EUT i.e. it should be equal to or exceed:

$$\frac{2(d_1+d_2)^2}{\lambda}$$

where:

- d_1 is the largest dimension of the EUT/dipole after substitution (m);
- d_2 is the largest dimension of the test antenna (m);
- λ is the test frequency wavelength (m).

It should be noted that in the substitution part of this measurement, where both test and substitution antennas are half wavelength dipoles, this minimum range length for far-field testing would be:

$$2\lambda$$

It should be noted in the test report when either of these conditions is not met so that the additional measurement uncertainty can be incorporated into the results.

NOTE 1: **For the fully anechoic chamber**, no part of the volume of the EUT should, at any angle of rotation of the turntable, fall outside the "quiet zone" of the chamber at the nominal frequency of the test.

NOTE 2: The "quiet zone" is a volume within the anechoic chamber (without a ground plane) in which a specified performance has either been proven by test, or is guaranteed by the designer/manufacture. The specified performance is usually the reflectivity of the absorbing panels or a directly related parameter (e.g. signal uniformity in amplitude and phase). It should be noted however that the defining levels of the quiet zone tend to vary.

NOTE 3: **For the anechoic chamber with a ground plane**, a full height scanning capability, i.e. 1 m to 4 m, should be available for which no part of the test antenna should come within 1 m of the absorbing panels. For both types of **anechoic chamber**, the reflectivity of the absorbing panels should not be worse than -5 dB.

NOTE 4: **For both the anechoic chamber with a ground plane and the OATS**, no part of any antenna should come within 0,25 m of the ground plane at any time throughout the tests. Where any of these conditions cannot be met, measurements should not be carried out.

A.2.6 Site preparation

The cables for both ends of the test site should be routed horizontally away from the testing area for a minimum of 2 m (unless, in the case both types of **anechoic chamber**, a back wall is reached) and then allowed to drop vertically and out through either the ground plane or screen (as appropriate) to the test equipment. Precautions should be taken to minimize pick up on these leads (e.g. dressing with ferrite beads, or other loading). The cables, their routing and dressing should be identical to the verification set-up.

NOTE: For ground reflection test sites (**i.e. anechoic chambers with ground planes and OATS**) which incorporate a cable drum with the antenna mast, the 2 m requirement may be impossible to comply with.

Calibration data for all items of test equipment should be available and valid. For test, substitution and measuring antennas, the data should include gain relative to an isotropic radiator (or antenna factor) for the frequency of test. Also, the VSWR of the substitution and measuring antennas should be known.

The calibration data on all cables and attenuators should include insertion loss and VSWR throughout the entire frequency range of the tests. All VSWR and insertion loss figures should be recorded in the log book results sheet for the specific test.

Where correction factors/tables are required, these should be immediately available.

For all items of test equipment, the maximum errors they exhibit should be known along with the distribution of the error e.g.:

- cable loss: $\pm 0,5$ dB with a rectangular distribution;
- measuring receiver: 1,0 dB (standard deviation) signal level accuracy with a Gaussian error distribution.

At the start of measurements, system checks should be made on the items of test equipment used on the test site.

A.3 Coupling of signals

A.3.1 General

The presence of leads in the radiated field may cause a disturbance of that field and lead to additional measurement uncertainty. These disturbances can be minimized by using suitable coupling methods, offering signal isolation and minimum field disturbance (e.g. optical and acoustic coupling).

A.3.2 Data signals

Isolation can be provided by the use of optical, ultra sonic or infra red means. Field disturbance can be minimized by using a suitable fibre optic connection. Ultra sonic or infra red radiated connections require suitable measures for the minimization of ambient noise.

A.3.3 Speech and analogue signals

Where an audio output connector is not available an acoustic coupler should be used.

When using the acoustic coupler, care should be exercised that possible ambient noise does not influence the test result.

A.3.3.1 Acoustic coupler description

The acoustic coupler comprises a plastic funnel, an acoustic pipe and a microphone with a suitable amplifier. The materials used to fabricate the funnel and pipe should be of low conductivity and of low relative dielectric constant (i.e. less than 1,5).

- the acoustic pipe should be long enough to reach from the EUT to the microphone which should be located in a position that will not disturb the RF field. The acoustic pipe should have an inner diameter of about 6 mm and a wall thickness of about 1,5 mm and should be sufficiently flexible so as not to hinder the rotation of the turntable;
- the plastic funnel should have a diameter appropriate to the size of the loudspeaker in the EUT, with soft foam rubber glued to its edge, it should be fitted to one end of the acoustic pipe and the microphone should be fitted to the other end. It is very important to fix the centre of the funnel in a reproducible position relative to the EUT, since the position of the centre has a strong influence on the frequency response that will be measured. This can be achieved by placing the EUT in a close fitting acoustic mounting jig, supplied by the manufacturer, of which the funnel is an integral part;
- the microphone should have a response characteristic flat within 1 dB over a frequency range of 50 Hz to 20 kHz, a linear dynamic range of at least 50 dB. The sensitivity of the microphone and the receiver audio output level should be suitable to measure a signal to noise ratio of at least 40 dB at the nominal audio output level of the EUT. Its size should be sufficiently small to couple to the acoustic pipe;
- the frequency correcting network should correct the frequency response of the acoustic coupler so that the acoustic SINAD measurement is valid (see IEC 60489-3 appendix F [8]).

A.3.3.2 Calibration

The aim of the calibration of the acoustic coupler is to determine the acoustic SINAD ratio which is equivalent to the SINAD ratio at the receiver output.

Annex B (normative): Spectrum analyser specification

Where methods of measurements refer to the use of a spectrum analyser. The characteristics of the spectrum analyser shall meet at least the following requirements:

- the reading accuracy of the frequency marker shall be within ± 100 Hz;
- the accuracy of relative amplitude measurements shall be within $\pm 3,5$ dB.

It shall be possible to adjust the spectrum analyser to allow the separation on its screen of two equal amplitude components with a frequency difference of 100 Hz.

For statistically distributed modulations, the spectrum analyser and the integrating device (when appropriate) needs to allow determination of the power spectral density (energy per time and bandwidth), which has to be integrated over the bandwidth in question.

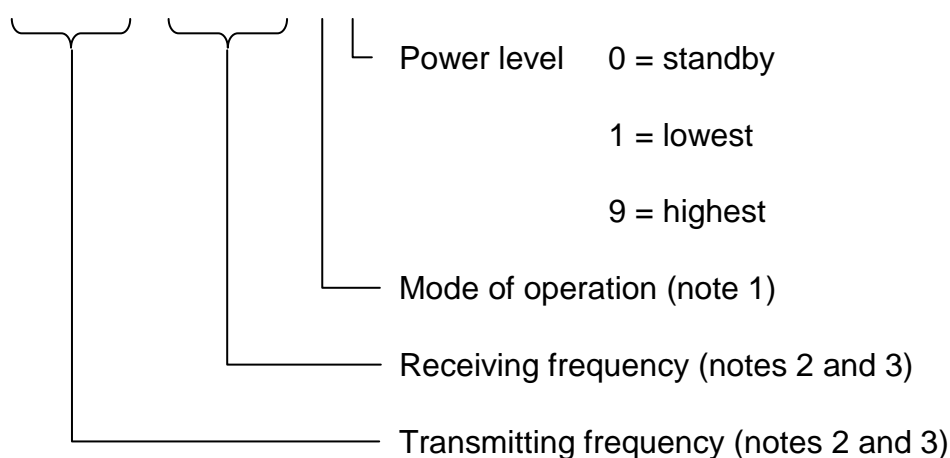
The spectrum analyser should have a dynamic range greater than 90 dB.

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

C.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 C.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 C.1: Frequency set information

History

Document history		
Edition 1	August 1995	Publication as ETS 300 373
Amendment 1	August 1997	Amendment 1 to 1 st Edition of ETS 300 373
V1.2.1	October 2002	Publication
V1.3.1	July 2010	Public Enquiry PE 20101030: 2010-07-02 to 2010-11-01
V1.3.1	November 2010	Vote V 20110108: 2010-11-09 to 2011-01-10