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Radio Equipment and Systems (RES); Technical characteristics and methods of measurement for maritime mobile transmitters and receivers for use in the MF and HF bands

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Foreword

This European Telecommunication Standard (ETS) has been produced by the Radio Equipment and Systems (RES) Technical Committee of the European Telecommunications Standards Institute (ETSI).

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

Transposition dates	
Date of adoption of this ETS:	26 June 1995
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1 Scope

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

This ETS 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 493-5 [5].

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

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

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

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

This ETS includes the International Maritime Organisation (IMO) and ITU requirements included in the relevant provisions of the Radio Regulations [1], the International Convention for the Safety Of Life At Sea (SOLAS) [3], and the IMO Resolutions A.421(XI), A.610(15), A.613(15), and A.694(17) [4].

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

2 Normative references

This ETS incorporates by dated or undated reference provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent references to or revisions of any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] ITU Radio Regulations.

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

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

[4] IMO Resolutions A.421(XI), A.610(15), A.613(15) and A.694(17).

[5] ITU-R Recommendation 493-5: "Digital Selective Calling System for use in the Maritime Mobile Service".

[6] NMEA 0183, Version 2.00: "Standard for interfacing marine electronic devices".

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

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

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

3 Definitions, abbreviations and symbols

3.1 Definitions

For the purposes of this ETS the following definitions apply:

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

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

3.2 Abbreviations

For the purposes of this ETS the following abbreviations apply:

AGC	Automatic Gain Control
DSC	Digital Selective Calling
EE	Equipment Engineering
emf	electromotive force
FSK	Frequency Shift Keying
IEC	International Electrotechnical Committee
IMO	International Maritime Organisation
ISO	International Standards Organisation
ITU	International Telecommunications Union
MF	Medium Frequency
MF/HF	Medium and High Frequency
MMS	Maritime Mobile Service
NBDP	Narrow Band Direct Printing telegraphy
NMEA	National Maritime Electronic Association
RMS	Root Mean Square
SNR	Signal-to-Noise Ratio
SOLAS	Safety Of Life At Sea
SSB	Single SideBand
USB	Upper SideBand

3.3 Symbols

For the purposes of this ETS the following symbols apply as defined in the Radio Regulations [1]:

F1B frequency modulation, single channel containing quantized or digital information without the use of a modulating sub-carrier, telegraphy for automatic reception.

H3E SSB, full carrier, single channel containing analogue information, telephony.

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.

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 with CCITT Recommendation E.161 [2]. However, where an alphanumeric keyboard layout is provided, the digits "0" to "9" may, alternatively, be arranged to conform with ISO Standard 3791 [7].

4.1.6 Audio frequencies interfaces

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

a) transmitters:

- SSB Telephony:
  - 600 Ω earth free audio input;
  - microphone input;
- DSC with analogue interfaces:
  - 600 Ω earth free audio input;
- DSC with digital interfaces:
  - NMEA 0183 Version 2.00 [6] input.

  The logic level and the appropriate functions shall comply with NMEA 0183 Version 2.00 [6]. The B-state shall be logic "0", and the Y-state shall be logic "1".

b) receivers:

- SSB Telephony:

  - 600 Ω earth free audio output;
  - earphone output;
  - speaker output;

- DSC with analogue interfaces:

  - 600 Ω earth free audio output;

- DSC with digital interfaces:

  - NMEA 0183, Version 2.00 [6] input.

  The logic level and the appropriate functions shall comply with NMEA 0183 Version 2.00 [6]. The B-state shall be logic "0", and the Y-state shall be logic "1".

c) control(s):

- if a control interface is provided to the equipment it shall meet NMEA 0183 Version 2.00 [6].

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

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 minimises the risk of inadvertent operation.

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

For receivers the class of emission shall be selectable by more than one control.

4.2.2 Ease of use

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

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 and H3E) 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 Synthesiser lock

It shall not be possible to transmit until any frequency synthesiser, 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 subclause 4.5 and the frequency ranges specified in subclause 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 attached to 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, the 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 hours 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 Upper Side Band (USB) 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;

H3E — SSB telephony on the frequency 2 182 kHz only with the carrier 4,5 dB - 6 dB below peak envelope power. For on-board test purposes, using only a dummy load, facilities shall be provided for H3E operation on the frequency of 2 200 kHz;

F1B — FSK suitable for DSC with a frequency shift of ± 85 Hz. Alternatively class of modulation J2B can be used with a 1 700 Hz sub-carrier. In this case the equipment shall be tuned to a carrier frequency 1 700 Hz below the assigned frequency.

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

4.6 Frequency bands

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

4.6.1 MF band

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

4.6.2 HF bands

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

4.7 Warming up period

4.7.1 Time

The equipment shall be operational and shall meet the requirements of this ETS one minute after switching on, except as provided in subclause 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 minutes from the instant of application of power to those parts shall be allowed, after which the requirements of this ETS shall be met.

4.7.3 Heating circuits

Where subclause 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 localisation 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.

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 subclauses 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 this ETS, the nominal voltage shall be the declared voltage or any one of the declared voltages for which the equipment was designed.

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

5.3.2.2 Secondary battery power sources

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

5.3.2.3 Other power sources

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

5.4 Extreme test conditions

5.4.1 Extreme temperature tests

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

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

5.4.2 Extreme values of test power source

5.4.2.1 Mains voltage and mains frequency

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

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

5.4.2.2 Secondary battery power sources

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

5.4.2.3 Other power sources

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

5.5 Artificial antennas

5.5.1 Transmitters

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

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

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

5.5.2 Receivers

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

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

The arrangement used shall be stated in the test report.

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

5.6 Standard test signals

5.6.1 Test signals applied to the receiver input

5.6.1.1 Sources

Sources of test signals for application to the receiver input shall be connected through a network such that the impedance presented to the receiver input is equal to that of the artificial antennas specified in subclause 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 subclause 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 subclauses.

5.6.2.1 Class of emission J3E

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

5.6.2.2 Class of emission H3E (2 182 kHz only)

Double-sideband signal, modulation frequency 1 000 Hz, modulation depth 30 %.

5.6.2.3 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.

Tests involving the use of class of emission H3E shall only be carried out on the carrier frequency 2 182 kHz.

5.7 Measurement uncertainty and interpretation of the measuring results.

5.7.1 Measurement uncertainty

Absolute measurement uncertainties: maximum values

RF frequency:	$\pm 1*10^{-8}$
RF Power:	± 0,75 dB
Conducted spurious emissions of transmitter:	± 4 dB
Audio output power:	± 0,5 dB
Sensitivity of receiver:	± 3 dB
Conducted emission of receiver:	± 3 dB
Two signal measurement:	± 4 dB
Three signal measurement:	± 3 dB

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

5.7.2 Interpretation of measurement results

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

- the measured value related to the corresponding limit will be used to decide whether an equipment meets the requirements of this ETS;

- the measurement uncertainty value for the measurement of each parameter shall be included in the test report;

- for each measurement, the recorded value of the measurement uncertainty shall be equal to or lower than the values in subclause 5.7.1.

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

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

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

6 Environmental tests

6.1 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.

6.2 Procedure

Environmental tests shall be carried out before tests of the same equipment in respect to the other requirements of this ETS 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.

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

6.3 Performance check

For the purpose of this ETS, 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 (subclause 5.5), the transmitter shall be tuned to the frequency 2 182 kHz. The transmitter frequency shall be within ± 10 Hz of 2 182 kHz.

- output power.

  With the transmitter connected to an artificial antenna (subclause 5.5), the transmitter shall be tuned to the frequency 2 182 kHz. When keyed without modulation, the output power of the transmitter (carrier power) shall be within 15 W and 100 W.

for the receiver:

- maximum usable sensitivity.

  With the AGC operative, the receiver shall be adjusted to 2 182 kHz and a test signal as specified in subclause 5.6.2.2 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 (subclause 8.1.1). The level of the input signal shall be less than + 36 dBµV.

6.4 Vibration test

6.4.1 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 minutes to cover each octave of frequency, the equipment shall be subjected to sinusoidal vertical vibration at all frequencies between:

- 5 Hz and 12,5 Hz with an excursion of ± 1,6 mm ± 10 %;

- 12,5 Hz and 25 Hz with an excursion of ± 0,38 mm ± 10 %;

- 25 Hz and 50 Hz with an excursion of ± 0,10 mm ± 10 %.

A resonance search shall be carried out during the vibration test. If resonance of any part of any component is observed, the equipment shall be subjected to vibration endurance test at each resonance frequency with the duration of not less than 2 hours at the vibration level specified above.

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 during the test.

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

It is recommended to perform the tests described in subclauses 7.4 and 8.3 during this test.

6.4.2 Requirement

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

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

6.5 Temperature tests

6.5.1 General

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

6.5.2 Dry heat

6.5.2.1 Internally mounted equipment

6.5.2.1.1 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 hours.

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

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

The equipment shall be subjected to a performance check during the 2 hours 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 hour. The equipment shall then be exposed to normal room temperature and humidity for not less than 3 hours before the next test is carried out.

6.5.2.1.2 Requirement

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

6.5.2.2 Externally mounted equipment

6.5.2.2.1 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 hours.

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 minutes.

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

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

The temperature of the chamber shall be maintained at + 55°C (± 3°C) during the 2 hour 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 hour. The equipment shall then be exposed to normal room temperature and humidity for not less than 3 hours before the next test is carried out.

6.5.2.2.2 Requirement

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

6.5.3 Damp heat

6.5.3.1 Method of measurement

The equipment shall be placed in a chamber at normal room temperature and humidity which, steadily, over a period of 3 hours (± 0,5 hour), 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 hours.

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

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

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

The temperature and the relative humidity of the chamber shall be maintained at + 40°C (± 3°C) and 93 % (± 2 %) during the 2 hours 30 minutes 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 hour. The equipment shall then be exposed to normal room temperature and humidity for not less than 3 hours, or until moisture has dispersed, which ever is longer, before the next test is carried out.

6.5.3.2 Requirement

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

6.5.4 Low temperature cycle

6.5.4.1 Internally mounted equipment

6.5.4.1.1 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 hours.

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 minutes.

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 hour. The equipment shall then be exposed to normal room temperature for not less than 3 hours, or until moisture has dispersed, which ever is longer, before the next test is carried out.

6.5.4.1.2 Requirement

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

6.5.4.2 Externally mounted equipment

6.5.4.2.1 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 hours.

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 minutes (± 5 minutes).

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

The equipment shall be subjected to a performance check during the last 30 minutes 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 hour. The temperature shall then be exposed to normal room temperature for not less than 3 hours, or until moisture has dispersed, which ever is longer, before the next test is carried out.

Throughout the test the equipment shall be working normally.

6.5.4.2.2 Requirement

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

6.6 Corrosion test

6.6.1 General

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

6.6.2 Method of measurement

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

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

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

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

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

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

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

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

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

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.

6.6.3 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 subclause 6.3 shall be fulfilled.

6.7 Rain test

6.7.1 General

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

6.7.2 Method of measurement

The equipment shall be placed in an appropriate measurement chamber.

Throughout the test the equipment shall be working normally.

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

The conditions to be observed are as follows:

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

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

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

6.7.3 Requirements

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

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

7 Transmitter

7.1 General

7.1.1 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 automatically to a value of 400 W or less, when the transmitter is switched to the MF band.

If the rated output power of the transmitter exceeds 150 W, provision shall be made for reducing the output power to a value of 60 W or less, except for distress frequencies where the output power shall be at least 60 W.

7.1.2 Class of emission

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

7.1.3 Class of emission on the distress frequency 2 182 kHz

7.1.3.1 Initial selection

When switching to the distress frequency 2 182 kHz, initially the class of emission, H3E, shall be selected automatically.

7.1.3.2 Subsequent use

In order to permit the use of class of emission J3E, provision shall be made for overriding the automatic selection of H3E after the equipment has been switched to the frequency 2 182 kHz.

7.1.4 Radiotelephone alarm signal generator

The transmitter shall have a built in radiotelephone alarm signal generator meeting the requirements of subclause 7.15. Means shall be provided to monitor the transmission of the alarm signal acoustically.

Means shall be provided to test the alarm signal generator without transmission.

It shall be possible to transmit the alarm signal on any frequency provided.

7.1.5 Minimum number of operating frequencies

7.1.5.1 Transmitters operating between 1 605 - 4 000 kHz only

The transmitter shall have facilities for operation on 2 182 kHz for telephony and 2 187,5 kHz for DSC and shall have at least seven additional frequencies within the band.

7.1.5.2 Transmitters operating between 1 605 - 27 500 kHz

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

7.2 Frequency error

7.2.1 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.

7.2.2 Method of measurement

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

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

a) SSB telephony:

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

b) DSC with an analogue interface:

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

c) DSC with a digital interface:

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

7.2.3 Limits

The transmitter frequencies shall, after the warming-up period specified in subclause 4.7 be within ± 10 Hz of the frequencies calculated in accordance with the definitions in subclause 7.2.1.

7.3 Output power and intermodulation products

7.3.1 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 characterises the linearity of amplitude modulated transmitters and is defined in ITU-R Recommendation 326-6 (see annex A).

7.3.2 Method of measurement

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

a) For SSB telephony:

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

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

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

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

b) For DSC with an analogue interface:

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

c) For DSC with a digital interface:

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

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

7.3.3 Limits

7.3.3.1 Output power in the range 1 605 - 4 000 kHz for all modulation modes

At any frequency in the band 1 605 - 4 000 kHz the maximum peak envelope power or maximum mean power, as appropriate (see subclause 7.3.1), shall be within ± 1,5 dB of the manufacturer's declared value(s), shall be greater than 60 W and shall not exceed 400 W.

7.3.3.2 Output power in the range 4 - 27,5 MHz for all modulation modes

At any frequency in the maritime bands between 4 and 27,5 MHz the maximum peak envelope power or maximum mean power, as appropriate (see subclause 7.3.1), shall be within ± 1,5 dB of the manufacturer's declared value(s), shall be greater than 60 W, and shall not exceed 1 500 W.

7.3.3.3 Intermodulation products for SSB telephony modes

The value of intermodulation products shall not exceed 25 dB below the highest of the two tones.

7.3.3.4 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.

7.3.3.5 Output spectrum

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

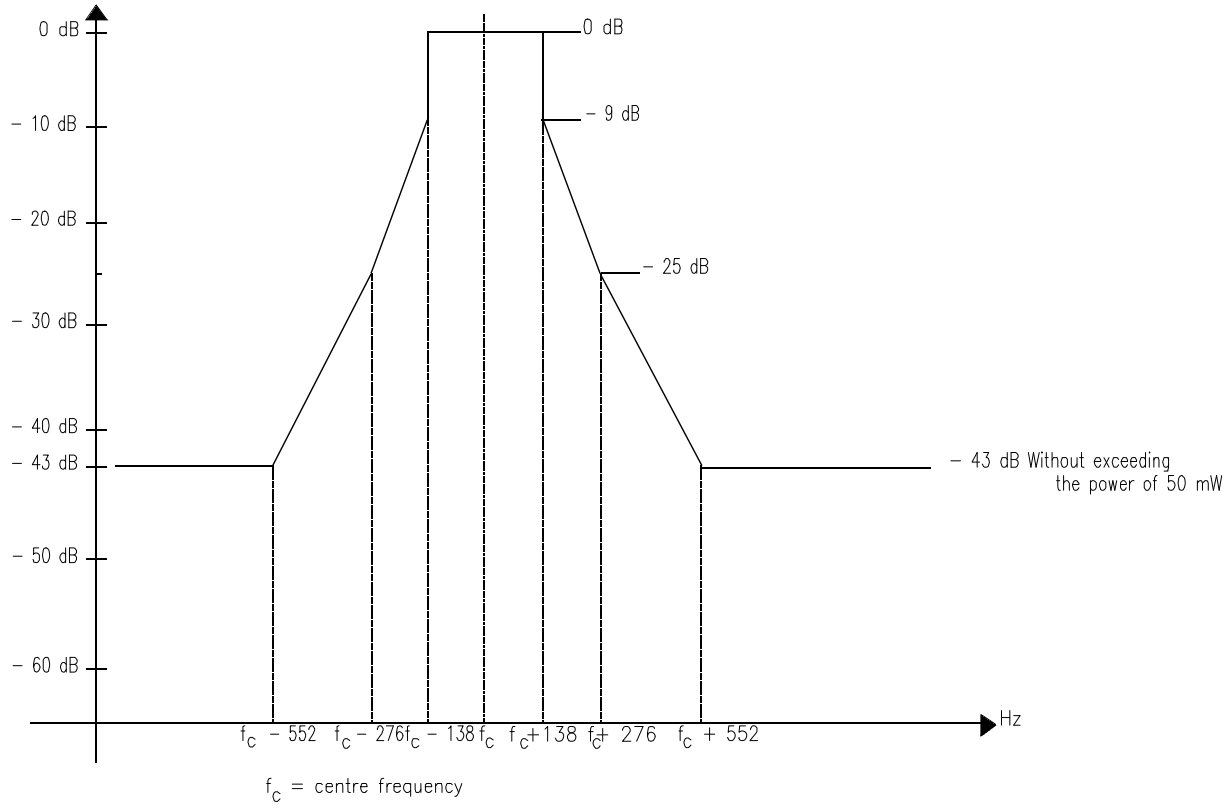


Figure 1: Limits

7.4 Unwanted frequency modulation

7.4.1 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.

7.4.2 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 subclause 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 subclause 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 subclause 7.3.

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

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

7.4.3 Limits

The frequency peak deviation shall not exceed ± 5 Hz.

7.5 Sensitivity of the microphone

7.5.1 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.

7.5.2 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.

7.5.3 Limits

The output power level shall be within - 3 dB and - 9 dB relative to the maximum output power as measured in subclause 7.3.

7.6 Sensitivity of the 600 Ω line input for SSB telephony

7.6.1 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.

7.6.2 Method of measurement

An audio tone with a frequency of 1 000 Hz and a level of - 6 dBm shall be applied to the 600 Ω line input terminals.

7.6.3 Limits

The output power level shall be within - 3 dB and - 9 dB relative to the maximum output power as measured in subclause 7.3.

7.7. 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.

7.7.1 Method of measurement

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

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

The level of the test signal shall be varied and the peak voltage of the input signal, together with the corresponding values of peak envelope power shall be measured at a sufficient number of points for a graph of input level against peak envelope power to be plotted. The graph shall be placed in figure 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.

7.7.2 Limits

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

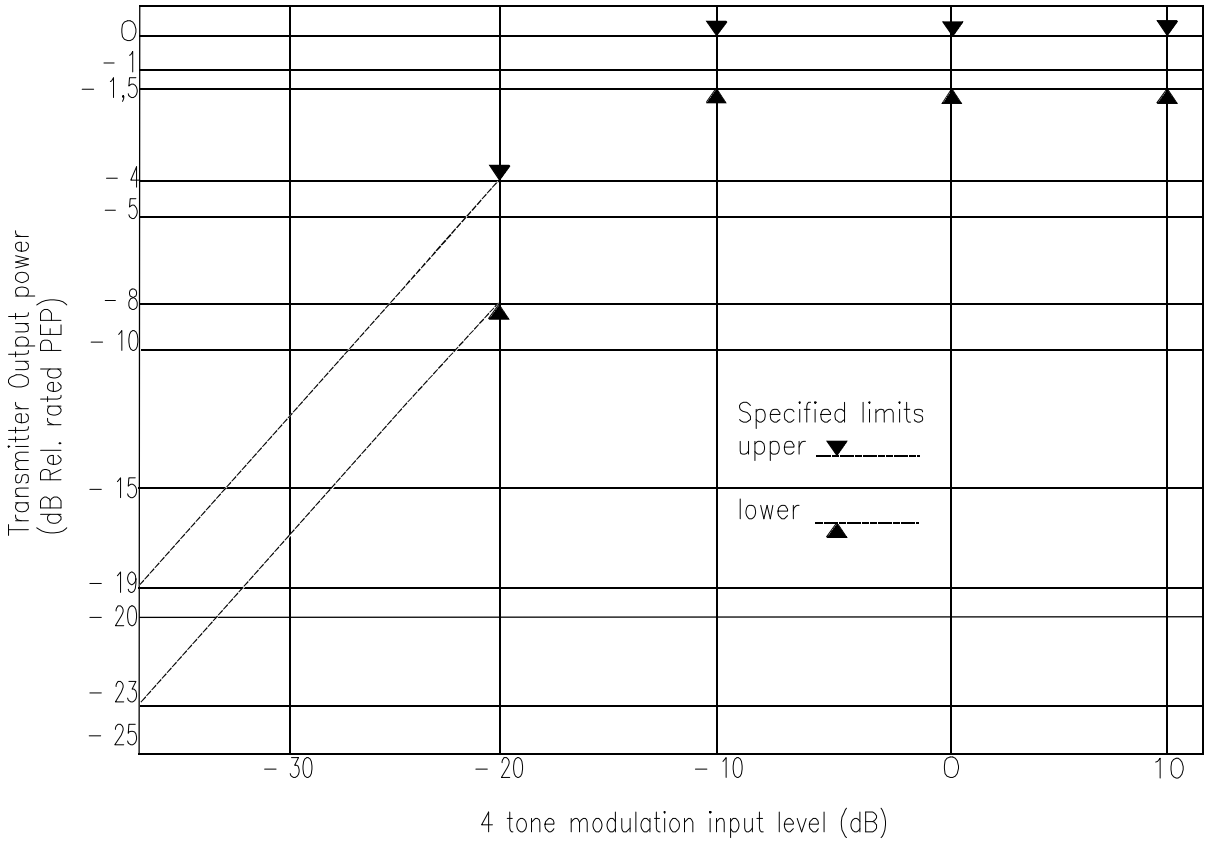


Figure 2: Limits

7.8 Audio frequency response of SSB telephony

7.8.1 Definition

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

7.8.2 Method of measurement

The transmitter shall be connected to the appropriate artificial antenna described in subclause 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).

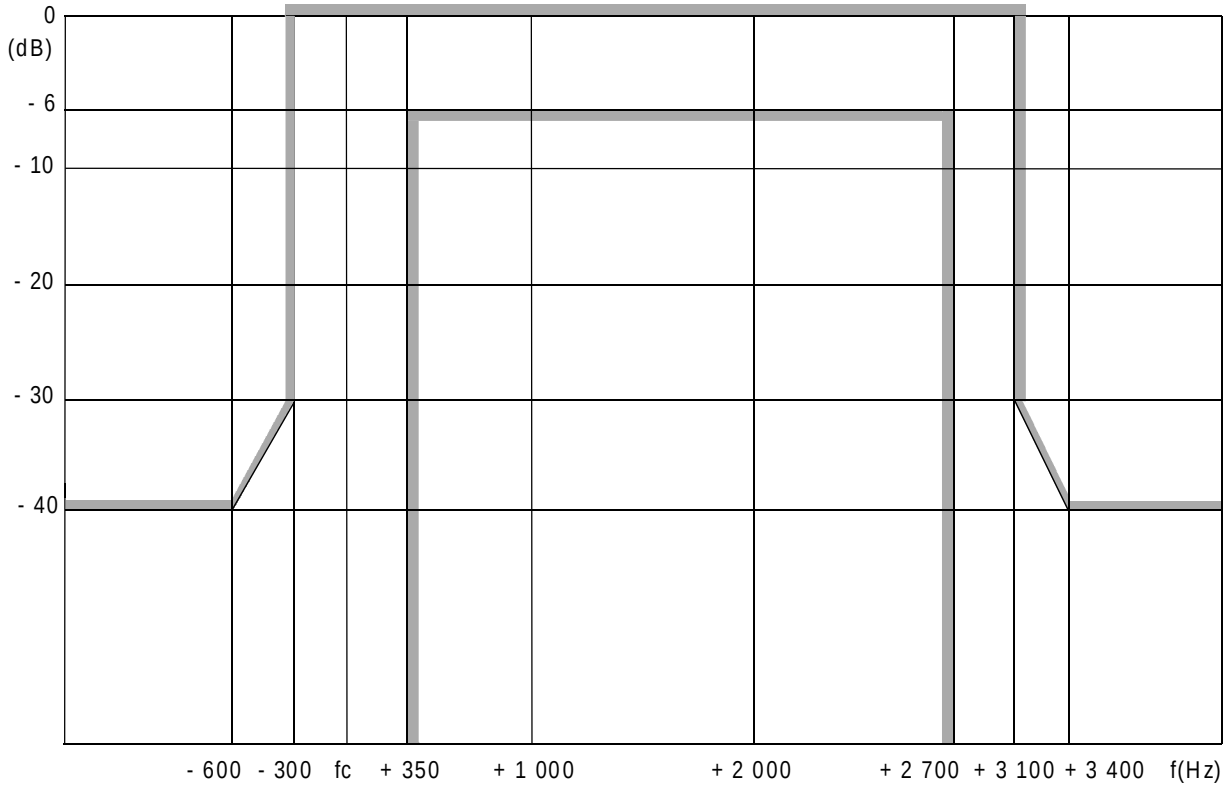
The level of the test signal shall be adjusted so that the output power at the peak of the response characteristic is 10 dB below the rated output power.

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

7.8.3 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

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

7.9.1 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.

7.9.2 Method of measurement

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

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

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

7.9.3 Limits

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

Table 2: Limits for out-of-band emissions

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

7.10 Power of conducted spurious emissions of SSB telephony

7.10.1 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.

7.10.2 Method of measurement

The transmitter shall be connected to the appropriate artificial antenna as specified in subclause 5.5.1. The modulation input shall be terminated by a 600 Ω termination, and the transmitter shall be placed in the transmit mode.

The spurious emissions shall be measured form 9 kHz to 2 GHz. The frequencies ± 12 kHz of the assigned frequency shall be excluded from this transmitter test.

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

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

7.10.3 Limits

The power of any conducted spurious emission supplied to the artificial antenna shall be in accordance with table 3.

Table 3: Limits for conducted spurious emissions

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

7.11 Residual hum and noise power for telephony

7.11.1 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.

7.11.2 Method of measurement

The transmitter shall be connected to the appropriate artificial antenna described in subclause 5.5.1. It shall then be modulated by a two-tone test signal to produce the maximum output power as measured in subclause 7.3.

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.

7.11.3 Limits

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

7.12 Residual frequency modulation on DSC

7.12.1 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.

7.12.2 Method of measurement

The transmitter shall be connected to the appropriate artificial antenna described in subclause 5.5.1. It shall then be modulated by a dot pattern to produce the maximum output power as measured in subclause 7.3.

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.

7.12.3 Limits

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

7.13 Carrier suppression

7.13.1 Definition

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

7.13.2 Method of measurement

The transmitter shall be connected to the appropriate artificial antenna described in subclause 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 subclause 7.3.

The carrier suppression shall be measured in both J3E and H3E modes as applicable.

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

7.13.3 Limits

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

The carrier suppression for modulation H3E shall be between 4,5 dB and 6 dB.

7.14 Continuous operation on telephony

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

7.14.1 Definition

7.14.2 Method of measurement

The transmitter shall be connected to the artificial antenna as specified in subclause 5.5.1 and driven to its maximum output power measured under subclause 7.3 using the two-tone test signal as described in subclause 7.3.2. The equipment shall transmit continuously for a period of 15 minutes.

For transmitters designed to operate only between 1,6 MHz and 4 MHz the test shall be carried out at 2 182 kHz in J3E mode.

Other transmitters shall be tested on a frequency in the 8 MHz band.

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

7.14.3 Limits

The output power shall not vary by more than ± 1,5 dB from the rated output power. The limits of subclause 7.3.3 shall not be exceeded.

7.15 Protection of transmitter

7.15.1 Definition

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

7.15.2 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 minutes. This test shall be conducted on one frequency only. The frequency chosen shall be recorded in the test report.

7.15.3 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.

7.16 Radiotelephone alarm signal requirements

7.16.1 Frequency and duration of tones

7.16.1.1 Definition

The radiotelephone alarm signal shall consist of two sinusoidal tones of 2 200 Hz and 1 300 Hz transmitted alternately.

7.16.1.2 Method of measurement

The transmitter shall be connected to an artificial antenna as defined in subclause 5.5.1 and the frequency 2 182 kHz selected. The alarm signal shall be activated and measured by a suitable receiver connected to an oscilloscope.

7.16.1.3 Limits

Each tone shall be within 1,5 % of its nominal frequency value and the duration of each tone shall be 250 ms (± 50 ms) and the interval between the tones, if any, shall not exceed 50 ms.

7.16.2 Duration of the alarm signal

7.16.2.1 Definition

After activation, the transmitter shall generate the tones automatically for a certain period unless manually interrupted. After manual interruption, the transmitter shall immediately be capable of generating the tones.

7.16.2.2 Method of measurement

The transmitter shall be connected to an artificial antenna as defined in subclause 5.5.1 and the frequency 2 182 kHz selected. The alarm signal shall be activated and the duration measured by means of a stop watch using the built in audio monitor.

7.16.2.3 Limit

After activation, the transmitter shall generate the tones for a period of at least 30 seconds and no more than 60 seconds.

7.16.3 Modulation depth

7.16.3.1 Definition

In order for watch-keeping receivers to react to the transmission of the alarm signal, it must be modulated to a minimum depth.

7.16.3.2 Method of measurement

The transmitter shall be connected to an artificial antenna as defined in subclause 5.5.1 and the frequency 2 182 kHz selected. The alarm signal shall be activated and the modulation depth measured by means of a suitable modulation analyser.

7.16.3.3 Limit

The modulation depth shall be 80 % ± 10 %. The variation between the two tones shall be less than 1,2 to 1.

8 Receiver

8.1 Receiver output powers

8.1.1 Standard output power

For the purposes of the following subclauses 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.

8.1.2 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 subclause 8.11.

8.2 Frequency error

8.2.1 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 subclause 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 subclause 5.6.2.3.

8.2.2 Method of measurement

a) SSB telephony:

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

b) DSC with analogue input:

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

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

8.2.3 Limits

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

8.3 Unwanted frequency modulation

8.3.1 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.

8.3.2 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 subclause 4.7 a radio frequency test signal as detailed in subclause 5.6.2.3 shall be applied to its input at a level of + 60 dBµV.

The receiver shall be adjusted to deliver standard output power at 1 kHz. The table shall be vibrated as detailed in subclause 6.4.1. Any frequency deviation of the output signal occurring during this test, shall be measured using a suitable, calibrated, FM demodulator.

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.

8.3.3 Limits

The frequency peak deviation shall not exceed ± 5 Hz.

8.4 Pass band

8.4.1 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.

8.4.2 Method of measurement

8.4.2.1 Class of emission J3E

With the AGC operative, two unmodulated radio frequency test signals shall be applied to the input of the receiver in accordance with subclause 4.7.1.

The frequency of one of these test signals shall be at a frequency 1 500 Hz above the carrier frequency to which the receiver is tuned, and its level shall be + 60 dBµV. This stabilises the gain of the receiver. The other test signal shall be at a level + 50 dBµV and shall be varied in frequency from the nominal carrier frequency to 10 kHz above the carrier frequency, and 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-stabilising input signal shall be displaced to a frequency just outside the pass-band of the measuring instrument.

8.4.2.2 Class of emission H3E

A test signal with a level of + 60 dBµV, modulated to a depth of 30 % at 1 000 Hz shall be applied to the receiver input, and the receiver shall be adjusted to give standard output power.

The modulation frequency shall then be varied from 10 Hz to 10 kHz above the carrier frequency, maintaining a constant depth of 30 %, and the output level corresponding to each modulating 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.

8.4.3 Limits

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

8.5 Maximum usable sensitivity

8.5.1 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.

8.5.2 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 subclause 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 subclause 5.3) and under extreme test conditions (see subclauses 5.4.1 and 5.4.2 applied simultaneously).

8.5.3 Limits

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

Table 4: Limits of maximum usable sensitivity

Frequency range and class of emission	**Maximum level of input of input signal (dBµV) 50 Ω or 10 Ω and 250 pF source impedance**	
	Normal conditions	Extreme conditions
1 605 - 4 000 kHz		
J3E	+ 16	+ 22
H3E	+ 30	+ 36
F1B	+ 0	+ 6
4 - 27,5 MHz		
J3E	+ 8	+ 14
F1B	+ 0	+ 6

8.6 Adjacent signal selectivity

8.6.1 Definition

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

8.6.2 Method of measurement

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

The wanted signal shall be in accordance with subclause 5.6.2.

Class of emission J3E or H3E and Class of emission F1B (analogue output)

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

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

Class of emission F1B (Digital output)

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

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

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

The wanted signal level shall be + 20 dBµV.

8.6.3 Limits

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

Table 5: Class of emission J3E

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

Table 6: Class of emission H3E

Carrier frequency of unwanted signal relative to carrier frequency of wanted signal	Adjacent signal selectivity
- 10 kHz and + 10 kHz	40 dB
- 20 kHz and + 20 kHz	50 dB

Table 7: 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 8: 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

8.7 Blocking

8.7.1 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.

8.7.2 Method of measurement

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

Class of emission J3E or F1B (analogue output)

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

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

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

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

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

Class of emission F1B (digital output)

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

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

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

8.7.3 Limits

Class of emission J3E or F1B (analogue output).

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

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

Class of emission F1B (digital output)

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

8.8 Cross modulation

8.8.1 Definition

Cross-modulation is the transfer of modulation from an unwanted, modulated signal on another frequency to the wanted signal.

8.8.2 Method of measurement

The tests shall be carried out on 2 182 kHz in H3E mode 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.

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

The wanted test input signal to the receiver shall be the normal test signal specified in subclause 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 modulated to a depth of 30 % at 400 Hz. The input level of the unwanted signal shall be increased until total unwanted power in the receiver output due to cross modulation is 30 dB below the level of the wanted signal.

The input of the unwanted signal, at which this condition is obtained, shall be taken as the cross modulation level.

8.8.3 Limits

The level of the unwanted signal shall not be less than + 90 dBµV.

8.9 Intermodulation

8.9.1 Definition

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

8.9.2 Method of measurement

8.9.2.1 Class of emission J3E.

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

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

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

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

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 maximise the reduction in SINAD ratio.

8.9.2.2 Class of emission H3E

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

With the wanted signal still applied, two other equal level 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. One of these signals shall be unmodulated and the other, that which has the greatest frequency separation from the wanted signal, shall be modulated to a depth of 30 % at 400 Hz.

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

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

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 maximise the reduction in SINAD ratio.

8.9.2.3 Class of emission F1B analogue

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

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

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

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

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 maximise the reduction in SINAD ratio.

8.9.2.4 Class of Emission F1B digital

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

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

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

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

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 maximise the reduction in bit error ratio.

8.9.3 Limits

The level of each of the two interfering signals which result in a 20 dB SINAD ratio at the receiver output shall be not less than + 80 dBµV for H3E and J3E and + 70 dBµV for analogue F1B.

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

8.10 Reciprocal mixing

8.10.1 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.

8.10.2 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 subclause 5.6.2 with a level of + 60 dBµV. The receiver shall be adjusted so that the wanted signal gives standard output power.

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

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

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

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

8.10.3 Results

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

8.11 Spurious response rejection ratio

8.11.1 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.

8.11.2 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 oscillater frequencies used;
- the coverage range;
- the pre first mixer filtering arrangements.

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

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

The following tests shall be made:

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

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

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

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

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

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

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

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

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

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

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

Class of emission J3E or H3E 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 subclause 5.6.2, the level shall be at the sensitivity level required in table 3.

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

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

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

Class of emission F1B (Digital output)

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

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

8.11.3 Limits

Class of emission J3E or H3E and Class of emission F1B (analogue output)

The spurious response rejection ratio shall not be less than 70 dB.

Class of emission F1B (Digital output)

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

8.12 Harmonic content in output

8.12.1 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.

8.12.2 Method of measurement

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

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

8.12.3 Limits

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

8.13 Audio frequency intermodulation

8.13.1 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.

8.13.2 Method of measurement

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

By means of the audio frequency gain control the total output power of the receiver shall be adjusted to standard output power (see subclause 8.1).

The audio frequency intermodulation components shall then be measured.

8.13.3 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.

8.14 Spurious emissions

8.14.1 Definition

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

8.14.2 Methods of measurement

Spurious emissions conducted to the antenna shall be measured by means of the connection of a 50 Ω resistor and a search shall be made for the presence of signals appearing across the resistor. The measurement shall be made over the frequency range 9 kHz to 4 GHz.

If receiver tests have been made with the artificial antenna described in subclause 5.5.2, a network consisting of a 10 Ω resistor and a 250 pF capacitor in series shall be substituted for the 50 Ω resistor mentioned above.

8.14.3 Limits

The power of any discrete component measured in the artificial antenna shall not exceed 2 nW from 9 kHz to 2 GHz and 20 nW from 2 GHz to 4 GHz.

8.15 Internally generated spurious signals

8.15.1 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.

8.15.2 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 subclause 4.6.2. 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.

8.15.3 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.

8.16 AGC efficiency

8.16.1 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.

8.16.2 Method of measurement and limits

8.16.2.1 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 subclause 4.7.2. The characteristics shall be checked at all audio outputs.

8.16.2.2 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 subclause 8.5. 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.

8.16.2.3 Range

Under the test conditions specified in subclause 8.15.2.1 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.

8.17 AGC time constants (attack and recovery time)

8.17.1 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.

8.17.2 Method of measurement

A test signal (see subclause 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.

8.17.3 Limits

Attack time: 5 - 10 ms;

Recovery Time: 1 - 4 seconds.

8.18 Protection of input circuits

8.18.1 Definition

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

8.18.2 Method of measurement

An unmodulated radio frequency test signal, at a level of 30 V RMS is applied, in the manner specified in subclause 5.6 to the receiver input for a period of 15 minutes, at any frequency in the range of frequencies over which the receiver is designed to operate.

8.18.3 Limit

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

Annex A (informative): Bibliography

- ITU-R Recommendation 332-4: "Selectivity of receivers".

- ITU-R Recommendation 326-6: "Determination and measurement of the power of radio transmitters".

- ETS 300 019-1-6: "Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-6: Classification of environmental conditions: Ship environments".

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