INTERNATIONAL STANDARD

IEC 61097-9

First edition
1997-12

Global maritime distress and safety system (GMDSS) –

Part 9: Shipborne transmitters and receivers for use in the MF and HF bands suitable for telephony, digital selective calling (DSC) and narrow band direct printing (NBDP) – Operational and performance requirements, methods of testing and required test results

Système mondial de détresse et de sécurité en mer (SMDSM) –

Partie 9: Emetteurs et récepteurs de bord de navires utilisables dans les bandes décamétriques et hectométriques pour la téléphonie, l'appel sélectif numérique (ASN) et l'impression directe à bande étroite (IDBE) – Exigences d'exploitation et de fonctionnement, méthodes d'essai et résultats d'essai exigés

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* See web site address on title page.

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FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 61097-9 has been prepared by IEC technical committee 80: Maritime navigation and radiocommunication equipment and systems.

The text of this standard is based on the following documents:

FDIS	Report on voting
80/147/FDIS	80/164/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

Annexes A, B and C are for information only.

The bilingual version of this standard will be issued later.

GLOBAL MARITIME DISTRESS AND SAFETY SYSTEM (GMDSS) –

Part 9: Shipborne transmitters and receivers for use in the MF and HF bands suitable for telephony, digital selective calling (DSC) and narrow band direct printing (NBDP) – Operational and performance requirements, methods of testing and required test results

1 Scope

This part of IEC 61097 specifies the minimum operational and performance requirements and methods of testing with required test results for transmitters and receivers capable of voice communication, digital selective calling and narrow band direct printing telegraphy for the GMDSS operating in either the medium frequency band only or in medium and high frequency bands allocated in the ITU Radio Regulations to the Maritime Mobile Service, as required by Chapter IV of SOLAS 1974 as amended in 1988 and which is associated with IEC 60945. When a requirement in this standard is different from IEC 60945, the requirement of this standard shall take precedence.

This standard refers to equipment for:

– single side-band (SSB) transmission and reception for radiotelephony;

– frequency shift keying or single side-band transmission and reception for digital selective calling signals (DSC) according to Recommendation ITU-R M.493-7; and

– frequency shift keying or single side-band transmission and reception for narrow band direct printing telegraphy (NBDP) according to Recommendation ITU-R M.625-3;

as applicable.

This standard refers to radio equipment, which is not integrated with DSC encoders or decoders, or NBDP modems, but defines the interfaces with, and the RF characteristics of, such equipment.

NOTE – The requirements for integrated DSC encoders or decoders may be found in IEC 61097-3 and for integrated NBDP modems in the future IEC 61097-11.

These requirements include the relevant provisions of the Radio Regulations and of the IMO Resolutions A.334(IX), A.421(XI), A.694(17), A.804(19), and A.806(19) and SOLAS.

NOTE – The requirement for two-tone generators (A.421(XI)) is only applicable until 1 February 1999.

If the equipment, or parts of it, is designed in such a manner that it can be used for other categories of maritime radiocommunication services (e.g. radio data or facsimile transmission), those parts of the equipment shall fulfil the relevant requirements of the appropriate standards for the service(s) in question.

NOTE – All text of this standard the wording of which is identical to that in IMO Resolutions and to that in the relevant ITU-R Recommendations is printed in *italics* and is prefixed by references (804 etc.) in brackets. When the text is identical in A.804 and A.806 the reference A.806 will be used.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 61097. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 61097 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60945:1996, *Maritime navigation and radiocommunication equipment and systems – General requirements – Methods of testing and required test results*

IEC 61097-3:1994, *Global maritime distress and safety system (GMDSS) – Part 3: Digital selective calling (DSC) equipment – Operational and performance requirements, methods of testing and required tests results*

IEC 61097-8 – *Global maritime distress and safety system (GMDSS) – Part 8: Shipborne watchkeeping receivers for reception of digital selective calling (DSC) in the maritime MF, MF/HF and UHF bands – Operational and performance requirements, methods of testing and required test results* [1)]

IEC 61162-1:1995, *Maritime navigation and radiocommunication equipment and systems – Digital interfaces – Part 1: Single talker and multiple listeners*

ISO 3791:1967, *Office machines and data processing equipment – Keyboard layouts for numeric applications*

International Convention on Safety of Life at Sea (SOLAS):1974 (as amended), *Chapter IV: Radiocommunications*

IMO Resolution A.334(IX):1975, *Recommendation on operational standards for radiotelephone transmitters and receivers*

IMO Resolution A.421(XI):1979, *Operational standards for radiotelephone alarm signal generators*

IMO Resolution A.694(17):1991, *General requirements for shipborne radio equipment forming part of the global maritime distress and safety system (GMDSS) and for electronic navigational aids*

IMO Resolution A.804(19):1995, *Performance standards for shipborne MF radio installations capable of voice communication and digital selective calling*

IMO Resolution A.806(19):1995, *Performance standards for shipborne MF/HF radio installations capable of voice communication, narrow-band direct-printing and digital selective calling*

ITU :1994, *Radio Regulations*

ITU-R M.493-7:1995, *Digital selective-calling system for use in the maritime mobile service*

ITU-R M.625-3:1995, *Direct-printing telegraph equipment in the maritime mobile service*

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1) To be published.

ITU-T E.161 (formerly 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*

ITU-T V.11:1993, *Electrical characteristics for balanced double-current interchange circuits operating at data signalling rates up to 10 Mbits/s*

3 Performance requirements

3.1 Introduction

(806/A1) *The MF or MF/HF radiotelephone, narrow band direct printing and digital selective calling installation, in addition to meeting the requirements of the Radio Regulations,* shall *comply with the following performance standards and with the general requirements as set out in Assembly Resolution A.694(17)* as specified in IEC 60945.

(806/A2.1) *The installation which may consist of more than one piece of equipment* shall *be capable of operating on single-frequency channels or on single- and two-frequency channels.*

(806/A2.2) *The equipment* shall *provide for the following categories of calling using both voice and digital selective calling (DSC):*

1 distress, urgency and safety;

2 ship operational requirements; and

3 public correspondence.

(806/A2.3) *The equipment* shall *provide for the following categories of communications using voice and* optionally *narrow band direct printing (NBDP) for* MF equipment and *both* for MF/HF equipment.

(806/A2.4) *The equipment* shall *comprise at least:*

1 a transmitter/receiver, including antenna(e);

2 an integral control unit and/or one or more separate control units;

3 a microphone with a press to transmit switch, which may be combined with a telephone in a handset;

4 an internal or external loudspeaker;

5 an integral or separate narrow band direct printing facility for MF/HF equipment; and

6 an integral or separate digital selective calling facility.

NOTE – (806/A2.4.7) The installation shall also comprise a dedicated DSC watchkeeping facility maintaining a continuous watch on distress channels only. Where a scanning receiver is employed to watch more than one DSC distress channel, all selected channels should be scanned within 2 s and the dwell time on each channel shall be adequate to allow detection of the dot pattern which precedes each DSC call. The scan shall only stop on detection of a 100 baud dot pattern (see IEC 61097-8).

3.2 Power supplies

(806/A3) *The MF* or *MF/HF radio installation* shall *be powered from the ship's main source of electrical energy. In addition, it* shall *be possible to operate the MF* or *MF/HF installation from an alternative source of electrical energy.*

3.3 Control

(806/A4) *It* shall *be possible to conduct distress and safety communications from the position or in the vicinity of the position, from which the vessel is normally navigated.*

3.4 Interfaces

Inputs and outputs applicable to the type of equipment shall be provided as follows:

– Transmitters:

SSB Telephony:	– 600 Ω earth free audio input
	– Microphone input
	– Keying line
DSC and NBDP with analogue interfaces:	– 600 Ω earth free audio input
	– Keying line
DSC and NBDP with digital interfaces:	– ITU-T V.11
	– Keying line

– Receivers:

SSB Telephony:	– 600 Ω earth free audio output
	– Earphone output
	– Speaker output
DSC and NBDP with analogue interfaces:	– 600 Ω earth free audio output
DSC and NBDP with digital interfaces:	– ITU-T V.11

– Control(s):

If a control interface is provided to the equipment it shall meet the requirements of IEC 61162-1. Other interfaces may be provided in addition. Connection of or failure within any external circuits shall not degrade the equipment.

3.5 Frequency indication

Radiotelephone frequencies (J3E and H3E) shall be designated in terms of the carrier frequency; NBDP and DSC frequencies (F1B and J2B) shall be designated in terms of the assigned (centre) frequency, as defined in the Radio Regulations, and shall be clearly identifiable on the control panel of the equipment. Independent choice and indication of transmitting and receiving frequencies shall be possible.

3.6 Distress controls

(806/A2.5) *A distress alert* shall *be activated only by means of a dedicated distress button. This button* shall *not be any key of an ITU-T* (E.161) *digital input panel or an ISO keyboard* (ISO 3791) *provided on the equipment.*

(806/A2.6) *The dedicated distress button* shall:

1 be clearly identified; and

2 be protected against inadvertent operation.

(806/A2.7) *The distress alert initiation* shall *require at least two independent actions.*

(806/A2.8) *The equipment* shall *indicate the status of the distress alert transmission.*

(806/A2.9) *It* shall *be possible to interrupt and initiate distress alerts at any time.*

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

3.7 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.

3.8 Labels

Labels shall be in accordance with IEC 60945.

Those of the following distress frequencies:

DSC (kHz)	Telephony (kHz)	NBDP (kHz)
2 187,5	2 182,0	2 174,5
4 207,5	4 125,0	4 177,5
6 312,0	6 215,0	6 268,0
8 414,5	8 291,0	8 376,5
12 577,0	12 290,0	12 520,0
16 804,5	16 420,0	16 695,0

applicable to the equipment, shall be clearly indicated, either on the front panel of the equipment or on an instruction label supplied with the equipment.

3.9 Safety precautions

3.9.1 Memories

The information in user programmable memory devices shall be protected from interruptions in the power supply of up to at least 24 h duration. Any software required to facilitate operation in accordance with this standard shall be permanently installed within the equipment.

Key parameters relating to the equipment and any software necessary for its initial activation or reactivation shall be stored in solid state non-volatile memory. Facilities shall be provided to protect all operational software incorporated in the equipment. It shall not be possible during routine use for the operator to augment, amend or erase any software in the equipment required for operation in accordance with this standard.

Means shall be provided to monitor the operational software of the equipment automatically at appropriate regular intervals, and to activate an alarm in the event of failure.

3.10 Classes of emission

The equipment shall provide for the transmission and reception of upper side-band signals using the classes of emission as appropriate for the equipment:

- J3E: single side-band telephony with the carrier suppressed at least 40 dB below peak envelope power;
- H3E: single side-band telephony on the frequency 2 182 kHz only with the carrier 4,5 dB to 6 dB below peak envelope power; and
- F1B: frequency shift keying suitable for digital selective calling with a frequency shift of ±85 Hz. (This may be achieved by use of a 1 700 Hz subcarrier. The class of modulation is then J2B).

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

3.11 Frequency bands

The equipment shall be capable of operating in either the MF frequency or in the MF and HF frequency bands.

3.11.1 MF frequency band

The equipment shall provide for the transmission and/or reception in the appropriate frequencies between 1 605 kHz and 4 000 kHz allocated in the Radio Regulations to the Maritime Mobile Service.

3.11.2 HF frequency bands

The equipment shall provide for the transmission and/or reception in the appropriate frequencies in the bands between 4 MHz and 27,5 MHz allocated in the Radio Regulations to the Maritime Mobile Service.

3.12 Warming-up period

3.12.1 Time

The equipment shall be operational and shall meet the requirements of this standard one minute after switching on, except as provided in 3.12.2.

3.12.2 Heaters

If the equipment includes parts which require to be heated in order to operate correctly, for example crystal ovens, then a warming-up period of 30 min from the instant of application of power to those parts shall be allowed, after which the requirements of this standard shall be met.

4 Transmitter

4.1 Frequencies and classes of emission

(806/B1.1) *The transmitter* shall *be capable of transmitting on* either:

(804/B1.1) *a number of frequencies in the bands between 1 605 kHz and 4 000 kHz considered by the administration as adequate for the operation of the ship, but at least on the frequencies 2 182 kHz and 2 187,5 kHz,* or on (806/B1.1) *all frequencies allocated to the maritime mobile service in the frequency band 1 605 kHz to 27 500 kHz. As a minimum, the following frequencies* shall *be readily accessible to the operator: the voice frequencies 2 182 kHz, 4 125 kHz, 6 215 kHz, 8 291 kHz, 12 290 kHz and 16 420 kHz; the NBDP frequencies 2 174,5 kHz, 4 177,5 kHz, 6 268 kHz, 8 376,5 kHz, 12 520 kHz and 16 695 kHz; and the DSC frequencies 2 187,5 kHz, 4 207,5 kHz, 6 312 kHz, 8 414,5 kHz, 12 577 kHz and 16 804,5 kHz*.

(806/B1.2) *Radiotelephone frequencies are designated in terms of the carrier frequency; NBDP and DSC frequencies are designated in terms of the assigned (centre) frequency. When NBDP and DSC signals are transmitted using a transmitter in the J2B mode the (suppressed) carrier frequency* shall *be adjusted so as to have the NBDP and the DSC signal transmitted on the assigned frequency. The selected transmitter frequency* shall *be clearly identifiable on the control panel of the transmitter.*

(806/B1.3) *The transmitter* shall *be capable of transmitting (upper side-band signals, where appropriate) using classes of emission J3E, H3E and either J2B* or *F1B.*

(806/B1.3.1) *When switching to the preset distress frequency 2 182 kHz, the appropriate class of emission in accordance with the Radio Regulations* shall *be selected automatically.*

(804/B1.3.2) *When switching to the preset distress frequency 2 187,5 kHz the class of emission J2B or F1B* shall *be selected automatically.*

(806/B1.3.2) *When switching to the assigned (centre) frequencies for NBDP and DSC classes of emission F1B or J2B* shall *be selected automatically.*

(806/B1.4) *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.*

(806/B1.5) *It* shall *be possible for the user to select transmission frequencies independent of any receiver setting. This does not preclude the use of transceivers.*

(806/B1.6) *It* shall *be possible to change the transmitter quickly from operation on any frequency to operation on any other frequency, and in any event within a period not exceeding 15 s. The equipment* shall *not be able to transmit during channel switching operations.*

(806/B1.7) *Means* shall *be provided to prevent over-modulation automatically.*

4.2 Frequency accuracy and stability

(806/B2) *The transmitted frequency* shall *remain within 10 Hz of the required frequency at all times following the warming-up period.*

4.3 Output power [1)]

(806/B3.1) *During normal modulation, the peak envelope power in the case of J3E or H3E emissions, or the mean power in the case of J2B* or *F1B emissions,* shall *be at least 60 W[2)] at any frequency within the specified frequency range.*

[1)] In determining the A2 area for MF coast stations an antenna efficiency of 25 % and an output power of 60 W for ship installations are assumed.

[2)] Note should be taken that in some areas of the world a 60 W value may not be adequate to ensure reliable communications. A value greater than 60 W may be required in these areas.

(806/B3.2) *If the rated output power exceeds 400 W*[3] *in the band, provision* shall *be made for reducing the output to 400 W or less* (806/B3.2). *Generally, only the minimum power necessary* shall *be used for all radio communications.*

(334/4.2) *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 shall be at least 60 W.

4.4 Transmitter input

For the transmission of voice signals, the transmitter shall have a microphone input, suitable to produce an output power level within –3 dB and –9 dB relative to full output power when a sound level of 94 dBA is applied to the microphone.

Additionally an input, earth free, of 600 Ω and 0 dBm shall be provided for analogue signals.

For digital signals, the input shall comply to ITU-T V.11 when provided.

4.5 Permissible warming-up period

(806/B4) *The equipment* shall *be capable of operation within 1 min after switching on.*

4.6 Continuous operation

(806/B5) *Continuous operation* shall *be possible when the transmitter is adjusted to operate at its rated power.*

4.7 Controls and indicators

(806/B6.1) *Provision* shall *be made for indicating the antenna current or power delivered to the antenna. Failure of the indicating system* shall *not interrupt the antenna circuit.*

(806/B6.2) *Manually tuned equipment* shall *be fitted with a sufficient number of indicators to permit accurate and rapid tuning.*

(806/B6.3) *Operation of the transmit/receive control* shall *not cause unwanted emissions.*

(806/B6.4) *All adjustment and controls necessary for switching the transmitter to operate on 2 182 kHz and 2 187,5 kHz* shall *be clearly marked in order that these operations may be performed readily.*

4.7.1 Telephony transmit control

In the manual simplex or semi-duplex telephony operating mode, switching from the receiving condition to the transmitting condition and vice versa, shall be accomplished by a single control. Any such control shall be located on the microphone or telephone handset and when at rest shall leave the equipment in the receive condition.

3) The Radio Regulations (RR 4357) specify a peak envelope power of 400 W for equipment operating in the MF band in region 1.

4.8 Safety precautions

(806/B7) *The equipment* shall *be so designed and constructed that when the transmitter is providing power to the antenna, the transmitter is protected against damage resulting from disconnection of the antenna or short-circuiting of antenna terminals. If this protection is provided by means of a safety device, that device* shall *automatically be reset following removal of the antenna open-circuit or short-circuit conditions.*

4.9 Power supply

(806/B8.1) *If it is necessary to delay the application of voltage, for example anode voltage, to any part of the transmitter after switching on, this delay* shall *be provided automatically.*

(806/B8.2) *If the transmitter includes parts which are required to be heated in order to operate correctly, for example crystal ovens, the power supplies to the heating circuits* shall *be so arranged that they can remain operative when other supplies to or within the equipment are switched off. If a special switch for the heating circuits is provided, its functions* shall *be clearly indicated; it* shall *normally be in the "on" position and be protected against inadvertent operation.* A visual indication that power is connected to such circuits shall be provided. *The correct operating temperature* shall *be reached within a period of* 30 min *after the application of power.*

4.10 Synthesizer lock

It shall not be possible to transmit until any frequency synthesizer is locked.

4.11 Channel switching

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

4.12 NBDP transmit and receive timing

In the NBDP operating mode switching from the receiving condition to the transmitting condition and vice versa, added together, shall be completed within 16 ms.

5 Receiver

5.1 Frequencies and classes of emission

(804/C1.1) *The receiver* shall *be capable of* either:

(804/C1.1) *being tuned throughout the bands between 1 605 kHz and 4 000 kHz. Tuning* shall *be either continuous, or incremental steps, or by the selection of a number of spot frequencies considered by the Administration as adequate for the operation of the ship, or by any combination of these methods. The frequencies 2 182 kHz and 2 187,5 kHz* shall *always be included;*

or (806/C1.1) *being tuned throughout the bands between 1 605 kHz and 27,5 MHz. Tuning* shall *be either continuous, or by incremental steps, or by the selection of a number of spot frequencies considered by the Administration as adequate for the operation of the ship, or by any combination of these methods. As a minimum, the following frequencies* shall *be readily accessible to the operator: the carrier frequencies 2 182 kHz, 4 125 kHz, 6 215 kHz, 8 291 kHz, 12 290 kHz and 16 420 kHz for radiotelephony; the NBDP frequencies 2 174,5 kHz, 4 177,5 kHz, 6 268 kHz, 8 376,5 kHz, 12 520 kHz and 16 695 kHz; and the DSC frequencies 2 187,5 kHz, 4 207,5 kHz, 6 312 kHz, 8 414,5 kHz, 12 577 kHz and 16 804,5 kHz.*

(806/C1.2) *Radiotelephone frequencies* shall *be designated in terms of the carrier frequency; NBDP and DSC frequencies* shall *be designated in terms of the assigned (centre) frequency. The selected receiver frequency* shall *be clearly identifiable on the control panel of the equipment.*

(806/C1.3) *The receiver* shall *be capable of receiving upper side-band signals as appropriate for classes of emission J3E, H3E, J2B and F1B.*

(806/C1.4) *The class of emission* shall *be selectable by not more than one control.*

(806/C1.5) *It* shall *be possible for the user to select reception frequencies independent of any transmitter setting. This does not preclude the use of transceivers.*

(806/C1.6) *The receiver* shall *be capable of being tuned to different frequencies quickly, and in any event within a period not exceeding 15 s.*

5.2 Frequency stability and accuracy

(806/C2) *The receiver frequency* shall *at all times remain within 10 Hz of the required frequency following the warming up period.*

5.3 Usable sensitivity

(806/C3) *For classes of emission J3E and F1B the sensitivity of the receiver* shall *be equal to or better than 6 μV e.m.f. at the receiver input for a signal-to-noise ratio of 20 dB. For NBDP and DSC an output character error rate of 10^{-2} or less* shall *be obtained for a signal-to-noise ratio of 12 dB.*

5.4 Receiver output

(806/C4.1) *For the reception of voice signals, the receiver* shall *be suitable for use with a loudspeaker and a telephone handset and* shall *be capable of providing power of at least 2 W to the loudspeaker and at least 1 mW to the handset.*

(806/C4.2) *An output*, earth free, shall *be provided for NBDP and DSC signals if the corresponding facility is not integrated.* The level shall be 0 dBm into a 600 Ω load impedance, adjustable ±10 dB. For digital signals, the output shall comply to ITU-T V.11 when provided.

5.5 Permissible warming-up period

(806/C5) *The equipment* shall *be capable of operating within 1 min after switching on.*

5.6 Immunity to interference

(806/C6) *The immunity to interference of the receiver* shall *be such that the wanted signal is not seriously affected by unwanted signals.*

5.7 Controls

(804/C7.1) *All adjustments and controls necessary for switching the receiver to operate on 2 187,5 kHz* shall *be clearly marked in order that these operations may be performed readily. the arrangements for switching the receiver to operate on 2 182 kHz* shall *also be clearly marked.*

(806/C7.2) *The receiver* shall *be provided with automatic gain control.*

5.8 Power supply

(804/C8) *If the receiver includes parts which are required to be heated in order to operate correctly, for example crystal ovens, the power supplies to the heating circuits* shall *be so arranged that they can remain operative when other supplies to or within the equipment are switched off. If a special switch for the heating circuits is provided, its function* shall *be clearly indicated; it* shall *normally be in the "on" position and be protected against inadvertent operation.* A visual indication that power is connected to such circuits shall be provided. *The correct operating temperature* shall *be reached within a period of 30 min after the application of power.*

5.9 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 d.c. path from the antenna terminal to ground not exceeding 100 kΩ.

5.10 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, when provided.

5.11 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.

5.12 Audio gain control and automatic gain control (AGC)

The receiver shall be provided with a control of audio frequency gain and with an AGC capable of operation on the classes of emission and the frequency ranges specified in 5.1.

5.13 NBDP transmit and receive timing

In the NBDP operating mode switching from the receiving condition to the transmitting condition and vice versa, added together, shall be completed within 16 ms.

6 Radiotelephone alarm signal generator [1)]

6.1 Introduction

(421/1.1) *The radiotelephone alarm signal generator, in addition to meeting the requirements of the Radio Regulations,* shall *comply with the following operational standards.*

6.2 General

(421/2.1) *The radiotelephone alarm signal generator* shall *preferably be an integral part of the radiotelephone transmitter, but may be a separate device.*

1) The radiotelephone alarm signal generator is only required until 1 February 1999.

6.3 Frequency and duration of tones

(421/3.1) *The frequency of both the 1 300 Hz and 2 200 Hz tones* shall *be maintained within a tolerance of ±1,5 %*.

(421/3.2) *The duration of each tone* shall *be 250 ms and be maintained within a tolerance of ±10 ms.*

(421/3.3) *The interval between successive tones* shall *be as short as possible but* shall *not exceed 4 ms.*

6.4 Modulation

(421/4.1) *The output of the device* shall *be sufficient to modulate the associated transmitter in the case of H3E class of emission to a depth of at least 70 percent and for an J3E class of emission to within 3 dB of the rated output power.*

(421/4.2) *When the transmitter is modulated, the ratio of the amplitude of the stronger radio frequency component to that of the weaker* shall *be within the range 1 to 1,2.*

6.5 Controls

(421/5.3) *The device* shall *be capable of being taken out of operation at any time in order to permit the immediate transmission of a distress message.*

6.6 Duration of alarm signal

(421/9.1) *After activation, the device* shall *automatically generate the radiotelephone alarm signal for a period of not less than 30 s and not more than 60 s, unless manually interrupted.*

6.7 Alarm signal repeat

(421/10.1) *After generating the radiotelephone alarm signal or after manual interruption the device* shall *be immediately ready to repeat the signal*.

6.8 Activation of the radio telephone transmitter

(421/11.1) *Provision* shall *be made such that, when the transmitter is operationally ready, the alarm signal generator will automatically switch the transmitter to the transmit condition at the start of the radiotelephone alarm signal and cause it to cease transmission at the conclusion of the signal.*

6.9 Aural monitoring

(421/12.1) *The device* shall *be provided with integral means for aural monitoring of the radiotelephone alarm signal with and without activating its associated transmitter.*

7 Methods of testing and required test results

Environmental tests shall be carried out before tests to verify whether the equipment under test (EUT) meets all technical requirements. Where electrical tests are required, these shall be done with the normal test voltage as specified in IEC 60945 unless otherwise stated.

In each test item indicated below, the related requirement can be identified by referring to the text with subclause number in brackets.

7.1 Test conditions

7.1.1 Normal and extreme test conditions

Tests shall be made under normal test conditions and also, where stated, under extreme test conditions as specified in IEC 60945, of dry heat and upper limit of supply voltage applied simultaneously and low temperature and lower limit of supply voltage applied simultaneously.

7.1.2 Procedure for tests at extreme temperatures

For tests at extreme temperatures, the EUT shall be placed in a test chamber and left until thermal equilibrium is reached. The EUT shall then be switched on for 30 min, after which it shall meet the requirements of this standard.

7.1.3 Test power source

During each test the EUT shall be supplied from a test power source, capable of producing normal and extreme test voltages. For the purpose of tests, the voltage of the power source shall be measured at the input terminals of the EUT. During tests, the power supply voltages shall be maintained within ±3 % relative to the voltage level at the beginning of each test.

7.1.4 Unspecified test conditions

Any requirement in clauses 3 to 6 for which no test is specified in clauses 7 to 9 shall be checked by inspection of the equipment, the manufacturing drawings or other relevant documents. The result of the inspection shall be stated in the test report.

7.2 Performance check

7.2.1 Definition

The performance check consists of checks as specified in 7.2.2 under normal test conditions.

7.2.2 Method of measurement

Where required in IEC 60945 a performance check shall be made, which shall include the following.

7.2.2.1 Transmitters (frequency error and output power)

With the transmitter connected to an artificial antenna (7.9.5) the transmitter shall be tuned to 2 182 kHz and operated in the J3E mode.

For frequency error the test signal of 8.2.2 for SSB shall be applied to the transmitter input.

For output power the test signal of 8.3.2 for SSB shall be applied to the transmitter input.

7.2.2.1.1 Results required

The output frequency shall be within ±10 Hz.

The output power shall be within 60 W PEP and 400 W PEP.

7.2.2.2 Receivers (maximum usable sensitivity)

With the AGC operative, the receiver shall be adjusted to 2 182 kHz in the J3E mode and the J3E test signal (7.9.2) 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 of 9.1.3.

7.2.2.2.1 Results required

The level of the input signal shall be less than 22 dBµV.

7.2.2.3 Two-tone alarm signal generators

A check of the alarm signal shall be made.

7.2.2.3.1 Results required

An alarm shall be generated.

7.3 Environmental tests

Environmental tests are intended to assess the suitability of the construction of the EUT for its intended physical conditions of use. After environmental tests, and, if specified also during the test, the EUT shall comply with the requirements of a performance check.

Environmental tests shall be carried out before any other tests. Where electrical tests are required, these shall be done with normal test voltage unless otherwise stated.

Environmental tests, as applicable to the category of equipment, shall be carried out as defined in IEC 60945, except as follows.

7.3.1 Dry heat cycle

The dry heat cycle test shall be performed as specified in IEC 60945, except that the initial 10 h to 16 h soak period shall be omitted.

7.3.2 Low temperature cycle

The low temperature cycle test shall be performed as specified in IEC 60945, except that the initial 10 h to 16 h soak period shall be omitted.

7.4 Electromagnetic compatibility (EMC)

Tests for EMC shall be performed as specified in IEC 60945.

7.5 Immunity

Tests for immunity shall be performed as specified in IEC 60945.

7.6 Acoustic noise

The manufacturer shall produce evidence that the EUT satisfies the acoustic noise requirements as specified in IEC 60945.

7.7 Compass safe distance

The compass safe distance shall be determined and labelled as specified in IEC 60945.

7.8 Safety precautions

Test shall be performed for applicable safety precautions requirements as specified in IEC 60945.

7.9 General conditions of measurement

7.9.1 Arrangements for test signals applied to the receiver input

For the purpose of testing, the receiver shall meet the requirements of this standard when connected as described below at the point at which the antenna is normally connected.

The 50 Ω network may be substituted, at the request of the manufacturer, by an network consisting of a 10 Ω resistor in series with a 250 pF capacitor for frequencies below 4 MHz. This shall in no way imply that the receiver should operate satisfactorily only with antennas having these impedance characteristics. The arrangement used shall be stated in the test report.

Test signals shall be connected through a network so that the impedance presented to the receiver antenna input is 50 Ω, except as permitted in 7.9.5, irrespective of whether one or more 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.

The level of the test input signals shall be expressed in terms of the electromotive force (e.m.f) which would exist at the output terminals of the source including the associated network.

7.9.2 Normal test signals applied to the receiver input

Except where otherwise stated, radio frequency test signals applied to the receiver input shall be as given below:

– Class of emission J3E:

  an unmodulated signal 1 000 Hz ± 0,1 Hz above the carrier frequency to which the receiver is tuned.

– Class of emission H3E (2 182 kHz only):

  a double side-band signal, modulation frequency 1 000 Hz, modulation depth 30 %.

– Class of emission F1B:

  DSC and NBDP with analogue interfaces: an unmodulated signal on the assigned frequency.

  DSC and NBDP with digital interfaces: a signal on the assigned frequency modulated as appropriate.

7.9.3 Arrangements for test signals applied to the transmitter input

Unless otherwise stated, the transmitter audio frequency modulation signal shall be supplied by a generator to an interface connected to the microphone input and this interface shall be provided by the manufacturer.

7.9.4 Normal test signals applied to the transmitter

Test signals for transmitter testing are specified in each appropriate test.

7.9.5 Artificial antennas

For the purpose of testing, the transmitter shall meet the requirements of this standard at the output of the antenna matching device when connected to the artificial antennas listed below. This shall in no way imply that the transmitter shall only work with antennas having these characteristics.

– 1 605 kHz to 4 000 kHz:

  The artificial antenna shall consist of a resistance of 10 Ω and a capacitance of 250 pF connected in series.

– 4 MHz to 27,5 MHz:

  The artificial antenna shall consist of a resistance of 50 Ω.

7.9.6 Testing frequencies

The frequencies used during each test shall be stated in the test report.

7.9.7 Bit error rate testing

BER testing is very time consuming especially when looking for a specific level such as a BER of 10^{-2}. It is therefore recommended that tests are made with the correct level signals and a pass or fail result is recorded in the test report, except for sensitivity tests in 9.5, where the absolute result is used as a reference for later tests (see annex A).

7.9.8 Measurement uncertainty

Maximum values of absolute measurement uncertainties shall be as follows:

RF frequency		$\pm 1 \times 10^{-8}$
RF power	(PEP in 10 Ω 250 pF)	±2,5 dB
	(PEP in 50 Ω)	±1,5 dB
Adjacent channel power		±5 dB
Conducted spurious of transmitter		±4 dB
Audio output power		±0,5 dB
Sensitivity at 20 dB SINAD		±3 dB
Conducted emission of receiver		±3 dB
Two-signal measurement		±4 dB
Three-signal measurement		±3 dB
Radiated emission of transmitter		±6 dB
Radiated emission of receiver		±6 dB

8 Transmitter

8.1 General

8.1.1 Frequencies and classes of emission

The transmitter shall provide upper side-band signals only or upper side-band and frequency shift keying signals in accordance with 3.10.

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

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

8.1.2 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.

8.1.3 Output indication

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

8.1.4 Radiotelephone alarm signal generator

The transmitter shall have a radiotelephone alarm signal generator meeting the requirements of clause 6.

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.

A transmitter operating between 1 605 kHz – 4 000 kHz only, 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.

A transmitter operating between 1 605 kHz – 27 500 kHz shall have facilities for operation on all frequencies allocated in the Radio Regulations to the Maritime Mobile Service. In addition facilities shall be provided to restrict operator frequency selection to these frequencies.

8.2 (4.2) Frequency error

8.2.1 Definition

The frequency error of the transmitter is:

– for SSB telephony:

The difference between the measured frequency minus 1 000 Hz and the nominal value of the frequency for the particular telephony frequency;

– for DSC and NBDP with an analogue interface:

The difference between the measured and the nominal assigned frequency; and

– for DSC and NBDP with a digital interface:

The difference between the measured Y-state frequency and the nominal assigned frequency minus 85 Hz and the difference between the measured B-state frequency and the nominal assigned frequency plus 85 Hz.

8.2.2 Method of measurement

The frequency shall be measured with the transmitter connected to an artificial antenna as defined in 7.9.5.

– 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 obtain the transmitter frequency.

– DSC and NBDP with an analogue interface:

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

– DSC and NBDP with a digital interface:

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

Measurements shall be carried out at the highest and lowest frequency available in the transmitter for telephony and, if provided, the digital DSC and NBDP interface or the analogue DSC and NBDP interface, if the digital interface is not provided.

The tests shall be performed under both normal and extreme test conditions, as defined in IEC 60945, of dry heat and upper limit of supply voltage applied simultaneously and low temperature and lower limit of supply voltage applied simultaneously.

8.2.3 Results required

The transmitter frequencies, after the warming-up period specified in 3.12, shall be within ±10 Hz of the frequencies defined in 4.1.

8.3 (4.3) Output power and intermodulation products

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.

8.3.1 Definitions

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

The rated output power is the power as declared by the manufacturer.

The intermodulation products level characterizes the non-linearity of amplitude modulated transmitters and is defined in Recommendation ITU-R M.326-6 (see annex B).

8.3.2 Method of measurement

The transmitter shall be connected to the appropriate artificial antenna as specified in 7.9.5.

– 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 not more than 1,5 dB below the rated output power as declared by the manufacturer. 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.

– DSC and NBDP 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.

– DSC and NBDP 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 and extreme test conditions, as defined in IEC 60945, of dry heat and upper limit of supply voltage applied simultaneously and low temperature and lower limit of supply voltage applied simultaneously.

Measurements shall be carried out at the highest and lowest frequency available in the transmitter for telephony and, if provided, the digital DSC and NBDP interface or the analogue DSC and NBDP interface, if the digital interface is not provided.

8.3.3 Results required

– Output power in the range 1 605 kHz – 4 000 kHz for all modulation modes:

  At any frequency in the band 1 605 kHz – 4 000 kHz the peak envelope power or mean power as appropriate, shall be more than 60 W and not exceed 400 W, and shall be within ±1,5 dB of the rated output power.

– Output power in the range 4 MHz – 27,5 MHz for all modulation modes:

  At any frequency in the maritime bands between 4 MHz and 28 MHz the peak envelope power or mean power as appropriate, shall be more than 60 W and not exceed 1 500 W, and shall be within ±1,5 dB of the rated output power.

– Intermodulation products for SSB telephony modes:

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

– 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.

– Output spectrum:

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

8.4 Unwanted frequency modulation

8.4.1 Definition

Unwanted frequency modulation is the deviation of output frequency of the transmitter which may occur due to a number of causes, e.g. vibration.

8.4.2 Method of measurement

The transmitter complete with chassis covers and shock absorbers (if supplied) shall be clamped in its normal operating position to a vibrating table and shall be connected to the appropriate artificial antenna as specified in 7.9.5. The transmitter shall then be switched on, adjusted for the transmission of class of emission J3E and, after the warming-up period permitted under 3.12, 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 8.3.

Any frequency deviation shall be measured by means of a monitoring receiver having a 6 dB bandwith of ±125 Hz and using a suitable calibrated FM demodulator or frequency deviation meter. The table shall be vibrated in accordance with IEC 60945.

The test shall be performed on 2 182 kHz if the transmitter is designed to work in the 1 605 kHz – 4 000 kHz band only, or on 8 291 kHz for J3E if the equipment is designed to work on all maritime bands in the 1 605 kHz – 27 500 kHz range.

8.4.3 Results required

The frequency peak deviation shall not exceed ±5 Hz.

8.5 Sensitivity of the microphone

8.5.1 Definition

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

8.5.2 Method of measurement

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

The test shall be performed on 2 182 kHz if the transmitter is designed to work in the 1 605 kHz – 4 000 kHz band only, or 8 291 kHz for J3E if the equipment is designed to work on all maritime bands in the 1 605 kHz – 27 500 kHz range.

8.5.3 Results required

The output power level shall be within –3 dB and –9 dB relative to the maximum output power as measured in 8.3.

8.6 Sensitivity of the 600 Ω line input for SSB telephony

8.6.1 Definition

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

8.6.2 Method of measurement

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

The test shall be performed on 2 182 kHz if the transmitter is designed to work in the 1 605 kHz – 4 000 kHz band only, or 8 291 kHz for J3E if the equipment is designed to work on all maritime bands in the 1 605 kHz – 27 500 kHz range.

8.6.3 Results required

The output power level shall be within –3 dB and –9 dB relative to the maximum output power as measured in 8.3.

8.7 Automatic level control and/or limiter for SSB telephony

8.7.1 Definition

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

8.7.2 Method of measurement

The transmitter shall be connected to the appropriate artificial antenna as specified in 7.9.5 and modulated to within 0 dB and –1 dB of the maximum output power as measured in 8.3, by a test signal consisting of four audio-frequency tones of equal amplitude, applied to the modulation input, at frequencies of 700 Hz, 1 100 Hz, 1 700 Hz and 2 500 Hz.

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

The level of the test signal shall be varied and the peak voltage of the input signal, together with the corresponding values of peak envelope power, shall be measured at a sufficient number of points for a graph of input level against peak envelope power to be plotted. The graph shall be placed in figure 2 in such a way that it touches the upper limits at two points at least, without exceeding the upper limits anywhere.

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

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

The test shall be performed on 2 182 kHz if the transmitter is designed to work in the 1 605 kHz – 4 000 kHz band only, or 8 291 kHz for J3E if the equipment is designed to work on all maritime bands in the 1 605 kHz – 27 500 kHz range.

8.7.3 Results required

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

8.8 Audio frequency response using SSB telephony

8.8.1 Definition

The audio frequency response is the variation of the output power as a function of the modulation audio frequency. The peak of the response is defined as the 0 dB line of the graph shown in figure 3.

8.8.2 Method of measurement

The transmitter shall be connected to the appropriate artificial antenna described in 7.9.5 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 analyzer).

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.

The test shall be performed on 2 182 kHz if the transmitter is designed to work in the 1 605 kHz – 4 000 kHz band only, or 8 291 kHz for J3E if the equipment is designed to work on all maritime bands in the 1 605 kHz – 27 500 kHz range.

8.8.3 Results required

The audio frequency response characteristic shall lie between the hatched areas shown in figure 3.

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

8.9.1 Definition

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

8.9.2 Method of measurement

The transmitter shall be connected to the appropriate artificial antenna as specified in 7.9.5 and driven to the maximum output power measured in 8.3 by a modulating signal consisting of two audio-frequency tones with a frequency separation between them so that all intermodulation products occur at frequencies at least 1 500 Hz removed from a frequency 1 400 Hz above the carrier.

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

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

8.9.3 Results required

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

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 dB
$1{,}5 < \Delta \leq 4{,}5$	31
$4{,}5 < \Delta \leq 7{,}5$	38
$7{,}5 < \Delta \leq 12$	43 without exceeding the power of 50 mW

8.10 Power of conducted spurious emissions of SSB telephony

8.10.1 Definition

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

8.10.2 Method of measurement

The transmitter shall be connected to the appropriate artificial antenna as specified in 7.9.5. The modulation input shall be terminated by a 600 Ω termination, and the transmitter shall be placed in a transmit mode.

The spurious emissions shall be measured from 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 f_c and f_c + 2,7 kHz shall be excluded from this transmitter test.

8.10.3 Results required

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

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

8.11 Residual hum and noise power using telephony

8.11.1 Definition

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

8.11.2 Method of measurement

The transmitter shall be connected to the appropriate artificial antenna described in 7.9.5. It shall then be modulated by a two-tone test signal to produce the maximum output power as measured in 8.3. The test signal shall then be disconnected from the transmitter modulation input terminals and the radio frequency power shall be measured at the transmitter output within a frequency band which lies between the carrier frequency and 2 700 Hz above the carrier frequency. The modulation input circuit terminals shall then be short-circuited and the radio frequency power shall be measured again.

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

The test shall be performed on 2 182 kHz if the transmitter is designed to work in the 1 605 kHz – 4 000 kHz band only, or 8 291 kHz for J3E if the equipment is designed to work on all maritime bands in the 1 605 kHz – 27 500 kHz range.

8.11.3 Results required

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

8.12 Residual frequency modulation on DSC and NBDP

8.12.1 Definition

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

8.12.2 Method of measurement

The transmitter shall be connected to the appropriate artificial antenna described in 7.9.5. It shall then be modulated by a dot pattern to produce the maximum output power as measured in 8.3.

The RF output terminal of the equipment shall be fed to a linear 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.

The r.m.s. output level shall be measured during transmission of continuous B or Y signals and during the transmission of continuous dot pattern.

The ratio of the two r.m.s. output levels from the demodulator shall be determined.

DC voltages shall be suppressed by an a.c. coupling device so that they do not influence the result of the measurement.

The test shall be performed on 2 187,5 kHz if the transmitter is designed to work in the 1 605 kHz – 4 000 kHz band only, or 8 414,5 kHz for F1B if the equipment is designed to work on all maritime bands in the 1 605 kHz – 27 500 kHz range.

8.12.3 Results required

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

8.13 (3.10) Carrier suppression

8.13.1 Definition

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

8.13.2 Method of measurement

The transmitter shall be connected to the appropriate artificial antenna described in 7.9.5. It shall then be modulated by an audio frequency of 1 000 Hz to produce the maximum output power as measured in 8.3. The carrier suppression shall be measured in both J3E and H3E modes as applicable.

The tests shall be performed under both normal and extreme test conditions, as defined in IEC 60945, of dry heat and upper limit of supply voltage applied simultaneously and low temperature and lower limit of supply voltage applied simultaneously.

The test shall be performed on 2 182 kHz if the transmitter is designed to work in the 1 605 kHz – 4 000 kHz band only, or 8 291 kHz for J3E if the equipment is designed to work on all maritime bands in the 1 605 kHz – 27 500 kHz range.

8.13.3 Results required

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.

8.14 Continuous operation

8.14.1 Definition

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

8.14.2 Method of measurement

The transmitter shall be connected to the artificial antenna as specified in 7.9.5 and driven to its maximum output power measured under 8.3, using for J3E transmitters the two-tone test signal as described in 8.3.2, and for DSC and NBDP transmitters continuous dot pattern. For a period of 15 min the equipment shall transmit continuously.

The test shall be performed on 2 182 kHz for J3E and 2 187,5 kHz for F1B if the transmitter is designed to work in the 1 605 kHz – 4 000 kHz band only, or on 8 291 kHz for J3E and 8 414,5 kHz for F1B if the equipment is designed to work on all maritime bands in the 1 605 kHz – 27 500 kHz range.

The measurement shall be carried out under extreme test conditions, as defined in IEC 60945, of upper limits of supply voltage and dry heat applied simultaneously.

8.14.3 Results required

The output power shall not vary by more than ±3 dB from the rated output power. The limits of 8.3.3 shall not be exceeded.

8.15 Protection of the transmitter

8.15.1 Definition

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

8.15.2 Method of measurement

After the transmitter has been tuned and whilst the transmitter is being driven to the rated output power by the simultaneous application of either two modulating signals of equal level or a dot pattern, the antenna terminals shall first be short-circuited and then open-circuited, in each case for a period of 5 min.

The test shall be performed on 2 182 kHz for J3E or 2 187,5 kHz for F1B if the transmitter is designed to work in the 1 605 kHz – 4 000 kHz band only, or on 8 291 kHz for J3E or 8 414,5 kHz for F1B if the equipment is designed to work on all maritime bands in the 1 605 kHz – 27 500 kHz range.

The test only needs to be carried out on one frequency and mode of operation.

8.15.3 Results required

During the test the transmitter shall not be damaged. After removal of the short-circuit or open-circuit conditions, the transmitter shall be able to operate normally for all available modes of operation.

8.16 Residual RF noise power

8.16.1 Definition

The residual RF noise output power of the transmitter is defined as the RF output power level with the transmitter not keyed, measured at the transmitter output and frequency in a 500 Hz bandwidth. This measurement is to ensure that residual noise of the transmitter does not generate interference which can affect the receiver performance in NBDP operation.

8.16.2 Method of measurement

Measurement of the residual RF noise output power of the transmitter shall be performed on 2 182 kHz for J3E or 2 187,5 kHz for F1B if the transmitter is designed to work in the 1 605 kHz – 4 000 kHz band only, or on 8 291 kHz for J3E or 8 414,5 kHz for F1B if the equipment is designed to work on all maritime bands in the 1 605 kHz – 27 500 kHz range.

The test only needs to be carried out on one frequency and mode of operation.

The transmitter shall be connected to the artificial antenna as specified in 7.9.5.

The transmitter shall be driven to the rated RF output power with 1 700 Hz modulation for analogue inputs and a continuous mark for digital inputs applied to the ARQ input.

The transmitter shall then be switched off using the key input intended to be operated from an ARQ unit.

8.16.3 Results required

The RF noise output power measured in a 500 Hz bandwidth supplied to the artificial antenna shall, within 12 ms after the transmitter has been switched off by means of the keying signal, decrease to a level below –150 dB relative to the RF output as measured in 8.3 or –93 dBm, whichever is the higher power level.

8.17 Switching time for NBDP

8.17.1 Definition

The switching time for NBDP transmitters is the time taken for the transmitter to reach 90 % of its output power with modulation present on the input when being switched from the receiving condition by the key normally used for the NBDP mode of operation.

8.17.2 Method of measurement

With the equipment in the receive condition a signal of 1 700 Hz for analogue inputs or a Y-state signal for digital inputs is applied to the transmitter modulation input normally used for NBDP at a level which will cause rated output of the transmitter.

A dummy load is connected to the transmitter output and the system tuned to 8 376,5 kHz.

An oscilloscope is connected to the dummy load in order to measure the transmitter switching time, the oscilloscope being triggered by the key line. Repetitive signals on the key line may be used to improve the measurement with a repetition rate of 450 ms to simulate ARQ signals.

8.17.3 Results required

The time from the key signal turning on the transmitter to the transmitter producing 90 % of the rated output power shall be recorded. The sum of the times recorded in 8.17.3 and 9.18.3 shall not exceed 16 ms.

9 Receiver

9.1 (5.4) Audio frequency output levels

9.1.1 Definition

The standard output power is defined as 1 mW for earphone reception, 500 mW for loudspeaker reception and 0 dBm into 600 Ω for the audio line outputs.

The rated output power is the output power declared by the manufacturer.

9.1.2 Method of measurement

The measurements are carried out at the same time as the measurements for the maximum usable sensitivity in 9.5.2.

The audio frequency output power shall be measured into a resistor equal to the nominal value of the load impedance declared by the manufacturer and 600 Ω respectively.

9.1.3 Results required

The output power shall be:

– for headphone reception at least 1 mW;

– for loudspeaker reception at least 2 W; and

– for audio line outputs 0 dBm into 600 Ω adjustable ±10 dB.

The total harmonic distortion at the rated output power shall meet the requirements of 9.6.

9.2 (5.2) Frequency error

9.2.1 Definition

The frequency error of the receiver is:

– 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 7.9.2;

– for DSC and NBDP 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 7.9.2; and

– for DSC and NBDP with a digital interface:

the absolute frequency error of a signal which causes a transition of the digital output.

9.2.2 Method of measurement

The test only needs performing in one modulation mode if the reference standard applies to all modes.

– 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.

– DSC and NBDP with analogue input if the EUT is not fitted for telephony:

A standard input signal for F1B shall be applied to the receiver on the assigned frequency to which it is tuned at a 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.

– DSC and NBDP with digital input if the EUT is not fitted for telephony or analogue input DSC and NBDP:

A standard input signal for F1B shall be applied to the receiver on a frequency 85 Hz above the assigned frequency. The input frequency shall be reduced slowly until a transition is seen on the receiver digital output. The test shall be repeated with the input frequency 85 Hz below the assigned frequency and the input frequency increased until a transition is seen. The difference between the mean value of the two transition frequencies and the assigned frequency is recorded.

The tests shall be performed under both normal and extreme test conditions, as defined in IEC 60945, of dry heat and upper limit of supply voltage applied simultaneously and low temperature and lower limit of supply voltage applied simultaneously.

The test shall be performed on 2 182 kHz for J3E or 2 187,5 kHz for F1B if the receiver is designed to work in the 1 605 kHz – 4 000 kHz band only, or 8 291 kHz for J3E or 8 414,5 kHz for F1B if the equipment is designed to work on all maritime bands in the 1 605 kHz – 27 500 kHz range.

9.2.3 Results required

The frequency error shall be less than ±10 Hz, after the warming-up period specified in 3.12.

9.3 Unwanted frequency modulation

9.3.1 Definition

Unwanted frequency modulation is the deviation of output frequency which may occur due to a number of causes, e.g. vibration.

9.3.2 Method of measurement

The receiver complete with chassis covers and shock absorbers (if supplied) shall be clamped in its normal operating position to a vibrating table. The receiver shall then be switched on, adjusted for the reception of class of emission J3E and after the warming-up period permitted under 3.12, a radio frequency test signal as detailed in 7.9.2 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 defined in IEC 60945. Any frequency deviation of the output signal occurring during this test shall be measured by means of a monitoring receiver having a 6 dB bandwith of ±125 Hz and using a suitable calibrated FM demodulator or frequency deviation meter.

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 for analogue interfaces. If the receiver is digital then an input signal is arranged at +85 Hz with respect to the assigned frequency and the output level checked.

The test shall be performed on 2 182 kHz for J3E or 2 187,5 kHz for F1B if the receiver is designed to work in the 1 605 kHz – 4 000 kHz band only, or 8 291 kHz for J3E or 8 414,5 kHz for F1B if the equipment is designed to work on all maritime bands in the 1 605 kHz – 27 500 kHz range.

9.3.3 Results required

The frequency peak deviation shall not exceed ±5 Hz for all analogue receivers.

The output shall be a B-state signal for digital receivers.

9.4 Audio frequency pass band

9.4.1 Definition

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

9.4.2 Method of measurement

– 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 7.9.1.

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

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

  The test shall be performed on 2 182 kHz for J3E if the receiver is designed to work in the 1 605 kHz – 4 000 kHz band only, or 8 291 kHz for J3E if the equipment is designed to work on all maritime bands in the 1 605 kHz – 27 500 kHz range.

– 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 analyzer or selective voltmeter, to enable the audio frequency pass band to be determined.

The test shall be performed on 2 182 kHz.

9.4.3 Results required

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

9.5 Maximum usable sensitivity

9.5.1 Definition

The maximum usable sensitivity is the minimum level of a radio frequency input signal with specified modulation which will produce at the receiver analogue outputs a chosen value of signal plus noise plus distortion to noise plus distortion ratio (abbreviated SINAD) 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 BER [1)].

9.5.2 Methods of measurement

With the AGC operative, tests shall be carried out with the receiver adjusted for each frequency range and class of emission for which it is designed. The test input signal to the receiver shall be the normal test signals specified in 7.9.2.

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 BER 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 test is carried out the tests shall be repeated with the input signal ±10 Hz of its nominal value.

The tests shall be performed under both normal and extreme test conditions, as defined in IEC 60945, of dry heat and upper limit of supply voltage applied simultaneously and low temperature and lower limit of supply voltage applied simultaneously.

[1)] The relationship between BER and symbol error rate for the coding system used in DSC and NBDP as defined in Recommendations ITU-R M.493 and M.625 is clarified in annex A.

9.5.3 Results required

The maximum usable sensitivity at a source impedance of 50 Ω, or 10 Ω and 250 pF shall be better than the values given in the table below:

Frequency range and class of emission	**Maximum level of input signal dBμV**	
	Normal conditions	Extreme conditions
1 605 kHz – 4 000 kHz		
J3E	+16	+22
H3E	+30	+36
F1B (digital output)	+5	+11
F1B (analogue output)	+10	+16
4 MHz – 27,5 MHz		
J3E	+11	+17
F1B (digital output)	+0	+6
F1B (analogue output)	+5	+11

9.6 Harmonic content in output

9.6.1 Definition

The harmonic content in the output of a telephony receiver is the total r.m.s. 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 r.m.s. output voltage when a single sinusoidal modulation is applied.

9.6.2 Method of measurement

This test shall be performed with both rated (as declared by the manufacturer and approved by the testing authority) and standard output power, as specified in 5.4. The test signals as defined in 7.9.2 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, as specified in 5.4, and then at the rated output power. The harmonic content shall then be measured.

9.6.3 Results required

The harmonic content shall not exceed 10 % at rated output power and 5 % at standard output power as specified in 5.4.

9.7 Adjacent channel selectivity

9.7.1 Definition

Adjacent channel 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.

The adjacent channel selectivity is defined, for the purpose of this standard, as the ratio of the levels at the receiver input, of a specified unwanted signal to a specified wanted signal, which result in a reduction of the SINAD, from 20 dB to 14 dB for analogue outputs or an increase of the BER to 10^{-2} for digital outputs.

9.7.2 Method of measurement

The arrangements for applying two test signals to the receiver input shall be according to 7.9.1. The AGC shall be in operation.

The wanted signal shall be in accordance with 7.9.2 for analogue outputs.

The wanted signal level shall be +20 dBµV for digital outputs.

– 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 of 20 dB.

  The unwanted signal shall be modulated 30 % at 400 Hz for J3E and H3E and unmodulated for F1B.

  The level of the unwanted signal shall be increased (starting from a low level), until the SINAD is decreased from 20 dB to 14 dB.

– Class of emission F1B (digital output):

  The unwanted signal shall have a level of 40 dB above the level of the wanted signal.

  Digital receivers shall have a BER of better than 10^{-2}.

The test shall be performed on 2 182 kHz for J3E or 2 187,5 kHz for F1B if the receiver is designed to work in the 1 605 kHz – 4 000 kHz band only, or 8 291 kHz for J3E or 8 414,5 kHz for F1B if the equipment is designed to work on all maritime bands in the 1 605 kHz – 27 500 kHz range.

9.7.3 Results required

The adjacent channel selectivity shall exceed the values given in the following tables:

– Class of emission J3E:

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

– Class of emission H3E:

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

– Class of emission F1B:

Carrier frequency of unwanted signal relative to carrier frequency of wanted signal – kHz	**Adjacent channel selectivity**
–0,5 and +0,5	40 dB (analogue output)
–0,5 and +0,5	BER ≤ 10^{-2} (digital output)

9.8 Blocking

9.8.1 Definition

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

9.8.2 Method of measurement

The tests shall be carried out 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.

The wanted test input signal to the receiver shall be the normal test signal specified in 7.9.2.

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.

– 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 9.5.

  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 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):

  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 +3 dB above the level equal to the maximum usable sensitivity of the receiver as measured in 9.5.

  The input level of the unwanted signal shall be set to a level of +100 dBμV when the wanted signal is at a level of +60 dBμV. The input level of the unwanted signal shall be set to a level of +60 dBμV when the wanted signal is at a level +3 dB above the level equal to the maximum usable sensitivity of the receiver as measured in 9.5.

The test shall be performed on 2 182 kHz for J3E or 2 187,5 kHz for F1B if the receiver is designed to work in the 1 605 kHz – 4 000 kHz band only, or 8 291 kHz for J3E or 8 414,5 kHz for F1B if the equipment is designed to work on all maritime bands in the 1 605 kHz – 27 500 kHz range.

9.8.3 Results required

– 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 maximum usable sensitivity level.

– Class of emission F1B (digital output):

  For both cases of input levels, the BER shall be 10^{-2} or better.

9.9 Cross-modulation

9.9.1 Definition

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

9.9.2 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 7.9.2.

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.

9.9.3 Results required

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

9.10 Intermodulation

9.10.1 Definition

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

9.10.2 Method of measurement

This test only needs to be carried out on J3E.

The test shall be performed on 2 182 kHz for J3E or 2 187,5 kHz for F1B if the receiver is designed to work in the 1 605 kHz – 4 000 kHz band only, or 8 291 kHz for J3E or 8 414,5 kHz for F1B if the equipment is designed to work on all maritime bands in the 1 605 kHz – 27 500 kHz range.

– 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.

– 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, and neither of these two signals shall have a frequency within 30 kHz from the wanted signal. Input frequencies likely to cause unwanted intermodulation products are in Recommendation ITU-R M.332-4, section 6.4 (see annex B).

When choosing the frequencies used for this measurement, care should be taken to avoid frequencies at which spurious responses occur. The input levels of the two interfering signals shall remain equal and shall be adjusted to reduce the SINAD at the receiver output to 20 dB, carefully adjusting the frequency of one of the unwanted signals to maximize the reduction in SINAD.

– 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 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. Input frequencies likely to cause unwanted intermodulation products are in Recommendation ITU-R M.332-4, section 6.4.

When choosing the frequencies used for this measurement, care should be taken to avoid frequencies at which spurious responses occur. The input levels of the two interfering signals shall remain equal and shall be adjusted to +70 dBμV. The frequency of one of the unwanted signals shall be carefully adjusted to maximize the increase in BER.

9.10.3 Results required

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

For F1B with a digital output, the level of each of the two interfering signals shall be +70 dBμV and the BER shall be equal to or better than 10^{-2}.

9.11 Spurious response rejection ratio

9.11.1 Definition

The spurious response rejection ratio is a measure of the ability of the receiver to discriminate between the wanted modulated input signal at the nominal frequency and an unwanted signal at any other frequency at which a response is obtained.

It is specified as the ratio in dB of the level of the unwanted signal to the level of the wanted signal at the receiver input.

For analogue signals it is the level where the SINAD is reduced from 20 dB or more to 14 dB. For digital signal outputs, the ratio of the signals shall be 70 dB without the BER exceeding 10^{-2}.

9.11.2 Method of measurement

NOTE – 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.

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

IF frequencies used;

local oscillator frequencies used;

coverage range; and

pre-first mixer filtering arrangements.

Tests 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 kHz and 4 000 kHz, and 8 291 kHz for J3E receivers and 8 367,5 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; and

a measurement of all frequencies defined by:

$n \times f_{LO1} \pm f_{IF1}$

$p \times f_R \pm f_{IF1}$

$f = (f_{LO2} \pm f_{IF2}) \pm f_{LO1}$;

where

n and p are integers

f_{LO1} is the local oscillator frequency of the first mixer

f_{LO2} is the local oscillator frequency of the second mixer

f_{IF1} is the first IF frequency

f_{IF2} is the second IF frequency

f_R is the receive frequency.

If no measurements are within 10 dB of the limit, the integers n and p need not exceed 10, otherwise the upper frequency of the test shall be 2 GHz.

Care shall 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 controls shall be adjusted in accordance with 9.5 (sensitivity test). All receiver controls shall remain unaltered during the remainder of the test.

Two signal generators shall be connected to the input of the receiver via a combining network.

The wanted signal shall be set to the nominal test frequency and shall be modulated in accordance with 7.9.2.

– Class of emission J3E and class of emission F1B (analogue output):

  The wanted signal shall be set to the sensitivity level defined in 9.5.3.

  The unwanted signal shall be set to at least 80 dB above the wanted signal and shall be varied in frequency to search, as defined above, for spurious responses between 100 kHz and 2 GHz, except for a band ±20 kHz of the wanted signal.

  For each spurious found, the level of the unwanted signal shall be reduced until a SINAD of 14 dB is achieved.

– Class of emission F1B (digital output):

  The wanted signal shall be set to be 3 dB above the sensitivity level defined in 9.5.3.

  The unwanted signal shall be set to at least 80 dB above the wanted signal and shall be varied in frequency to search, as defined above, for spurious responses between 100 kHz and 2 GHz, except for a band ±20 kHz of the wanted signal.

  For each spurious found, the level of the unwanted signal shall be reduced until the level is 70 dB above the wanted signal.

9.11.3 Results required

– Class of emission J3E and class of emission F1B (analogue output):

  The spurious response rejection ratio shall be 60 dB or better.

– Class of emission F1B with only digital output:

  The BER shall be 10^{-2} or better.

9.12 Audio frequency intermodulation

9.12.1 Definition

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

9.12.2 Method of measurement

With the AGC operative, the manual RF/IF gain control (if provided) at its maximum, and any input attenuator adjusted to its minimum attenuation, an unmodulated signal, 1 100 Hz above the frequency to which the receiver is tuned, at a level of 60 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 as defined in 9.1.1.

The audio frequency intermodulation components shall then be measured.

The measurement shall be carried out at 2 182 kHz.

9.12.3 Results required

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

9.13 Conducted spurious emissions into the antenna

9.13.1 Definition

Conducted spurious emissions are any radio frequency emissions generated in the receiver and radiated by way of conduction to the antenna.

9.13.2 Method of measurement

Spurious emissions conducted to the antenna port 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.

NOTE – If receiver tests have not been made with the 50 Ω network, a network consisting of a 10 Ω resistor and a 250 pF capacitor in series shall be substituted for the 50 Ω resistor.

9.13.3 Results required

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.

9.14 Internally generated spurious signals

9.14.1 Definition

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

9.14.2 Method of measurement

The receiver shall have no input signal and be terminated at its antenna input with a load impedance equal to those specified in 7.9.5. The receiver shall be set to J3E mode and a search made throughout the bands for whistles in the output. For conformance testing manufacturers may need to provide a means for quickly searching the bands in steps of no more than 1 kHz.

9.14.3 Results required

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

9.15 Improvement in signal-to-noise ratio with AGC

9.15.1 Definition

The improvement in signal-to-noise ratio is due to the inherent noise being attenuated as the signal strength is increased due to the application of AGC.

9.15.2 Method of measurement

Tests shall be performed on 2 182 kHz for J3E. The input signal shall be the appropriate normal test signal specified in 7.9.2. The characteristics shall be checked at all audio outputs.

The input signal shall have a level equal to the maximum usable sensitivity measured according to 9.5. The input level shall then be increased by 20 dB and the increase in signal-to-noise ratio measured.

9.15.3 Results required

The signal-to-noise ratio shall increase by at least 15 dB. Care should be taken in this measurement to minimize the effects of distortion.

9.16 AGC range

9.16.1 Definition

The AGC range is the range of the input signal in decibels that the AGC can maintain an output level within a 10 dB range.

9.16.2 Method of measurement

Tests shall be carried out with the receiver set to a frequency of 2 182 kHz in J3E. The input signal shall be the appropriate normal test signal specified in 7.9.2. The characteristics shall be checked at all audio outputs.

The input signal shall have a level equal to the maximum usable sensitivity measured according to 9.5 and 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 and the output level increase recorded.

9.16.3 Results required

The resulting increase in output power shall not exceed 10 dB.

9.17 AGC time constants (attack and recovery time)

9.17.1 Definition

– AGC attack time:

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

– AGC recovery time:

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

9.17.2 Method of measurement

A normal test signal as defined in 7.9.2 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 SINAD 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.

The test shall be repeated with the receiver set for F1B mode.

9.17.3 Results required

– Telephony mode:

Attack time: 5 ms – 10 ms

Recovery time: 1 s – 4 s

– F1B mode:

Attack time: 2 ms – 4 ms

Recovery time: 20 ms – 200 ms.

9.18 Switching time for NBDP

9.18.1 Definition

The switching time for NBDP receivers is the time taken for the receiver to reach full sensitivity when being switched from the transmitting condition by the key normally used for the NBDP mode of operation (see annex C).

9.18.2 Method of measurement

A signal is connected to the receiver at 8 376,5 kHz, unmodulated for analogue output receivers and modulated with dot pattern for digital output receivers, at the appropriate level for maximum usable sensitivity for analogue or digital outputs.

The transmitter is connected to a dummy load and is tuned to 8 376,5 kHz. It is driven to its rated power by either a modulation input of 1 700 Hz for analogue inputs or a mark for digital inputs and is keyed on by the normal key used for NBDP.

An oscilloscope is connected to the receiver output in order to measure the receiver switching time, the oscilloscope being triggered by the keying line. Repetitive signals on the keying line may be used to improve the measurement with a repetition rate of 450 ms to simulate ARQ signals.

9.18.3 Results required

The time from the key signal turning the transmitter off to the receiver producing 90 % of the correct output shall be recorded. The sum of the times recorded in 8.17.3 and 9.18.3 shall not exceed 16 ms.

9.19 Reciprocal mixing

9.19.1 Definition

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

9.19.2 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 7.9.2 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 signal-to-noise ratio to 30 dB. Care should be taken in this measurement to minimize the effects of distortion. The input level of the unwanted signal is recorded and shall be taken as the reciprocal mixing level.

Care should also be taken to ensure that the noise side-band of the generators representing the wanted, and especially the unwanted signals, does not influence the measurements.

9.19.3 Results required

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

9.20 Protection of input circuits

9.20.1 Definition

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

9.20.2 Method of measurement

An unmodulated radio frequency test signal, at a level of 30 V r.m.s. is applied to the receiver antenna input for a period of 15 min, at any frequency in the range of frequencies over which the receiver is designed to operate.

9.20.3 Results required

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

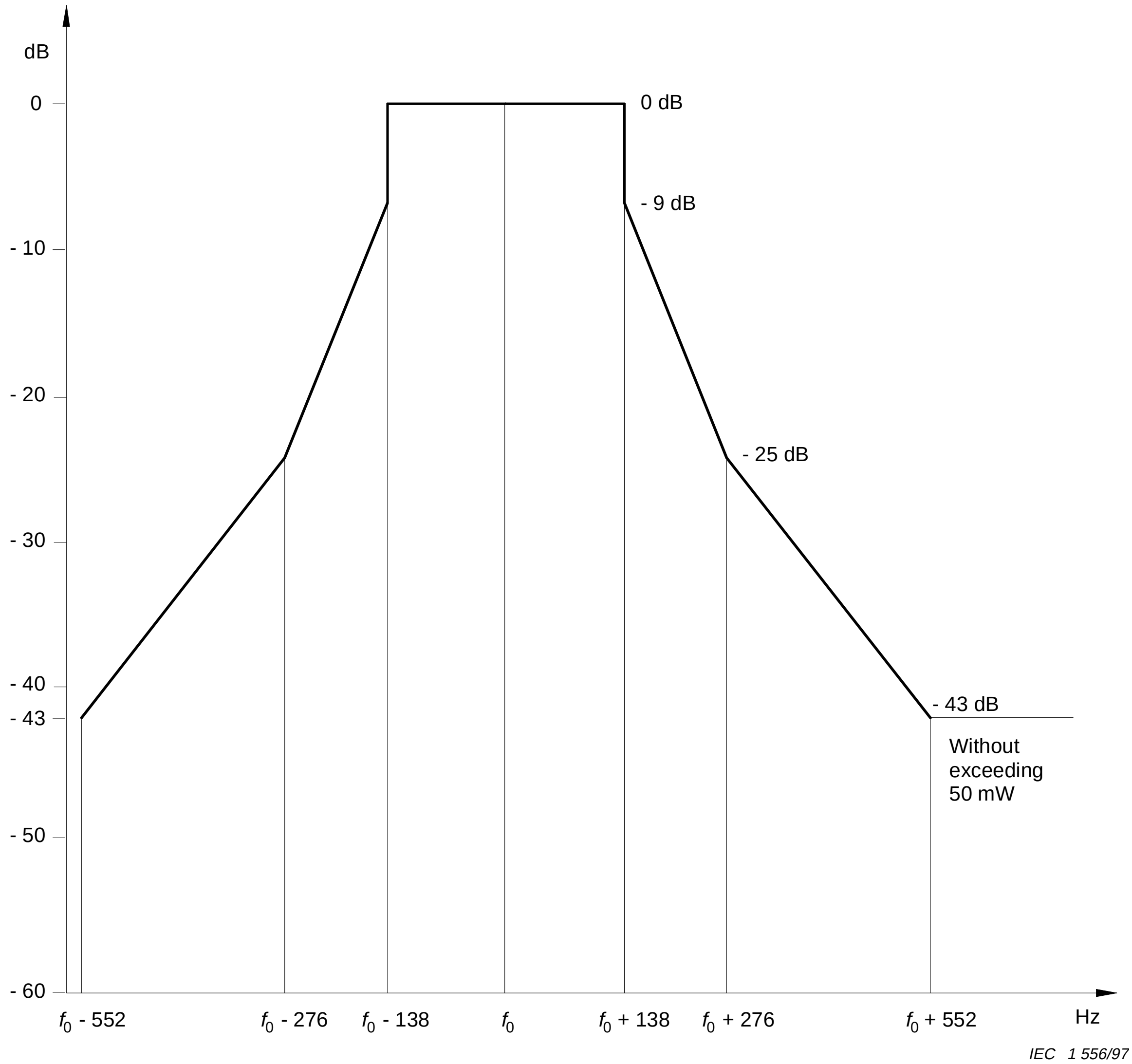

Figure 1 – Limits for unwanted emission (MF/HF transmitter)

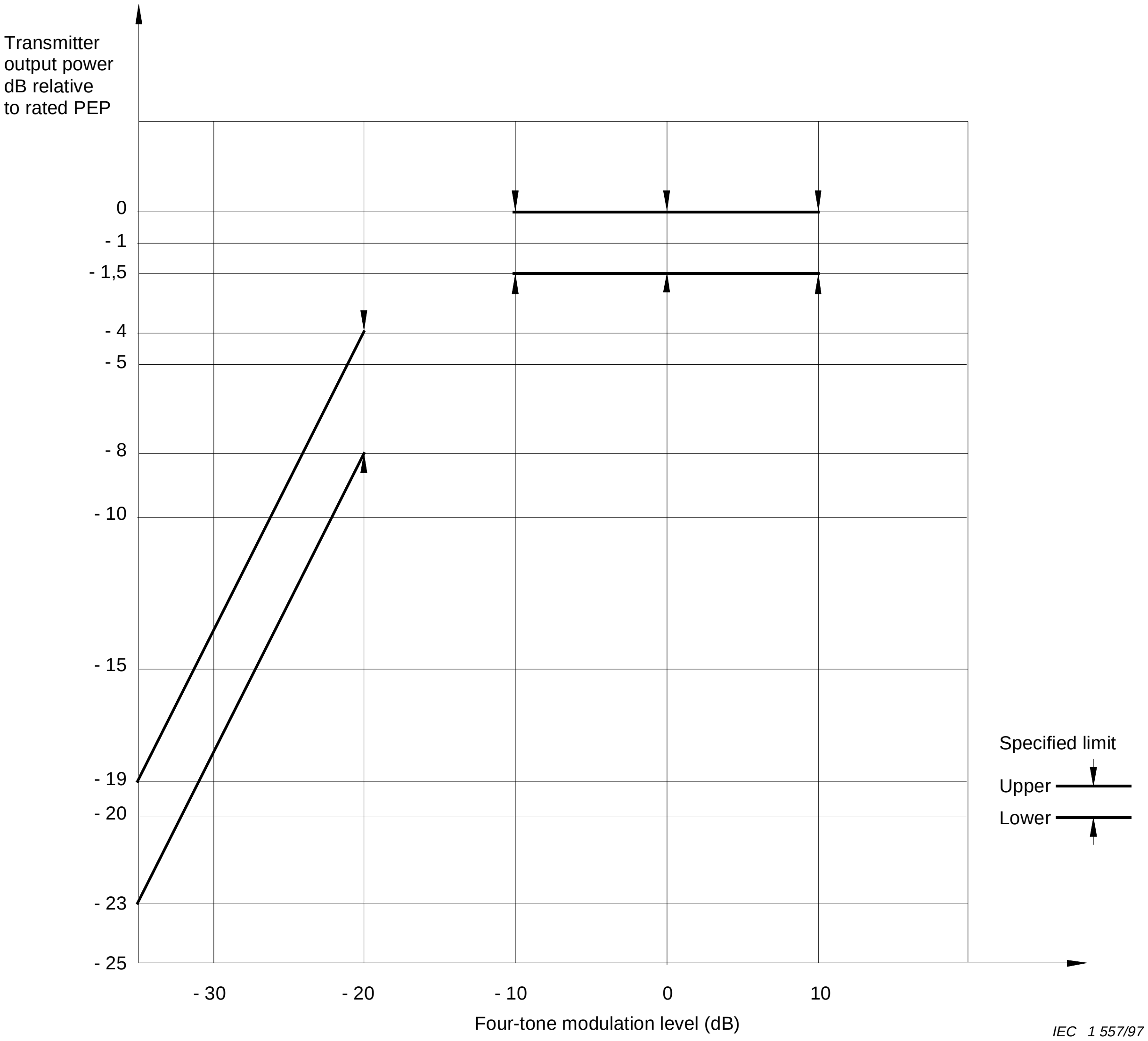

Figure 2 – Limits for automatic level control

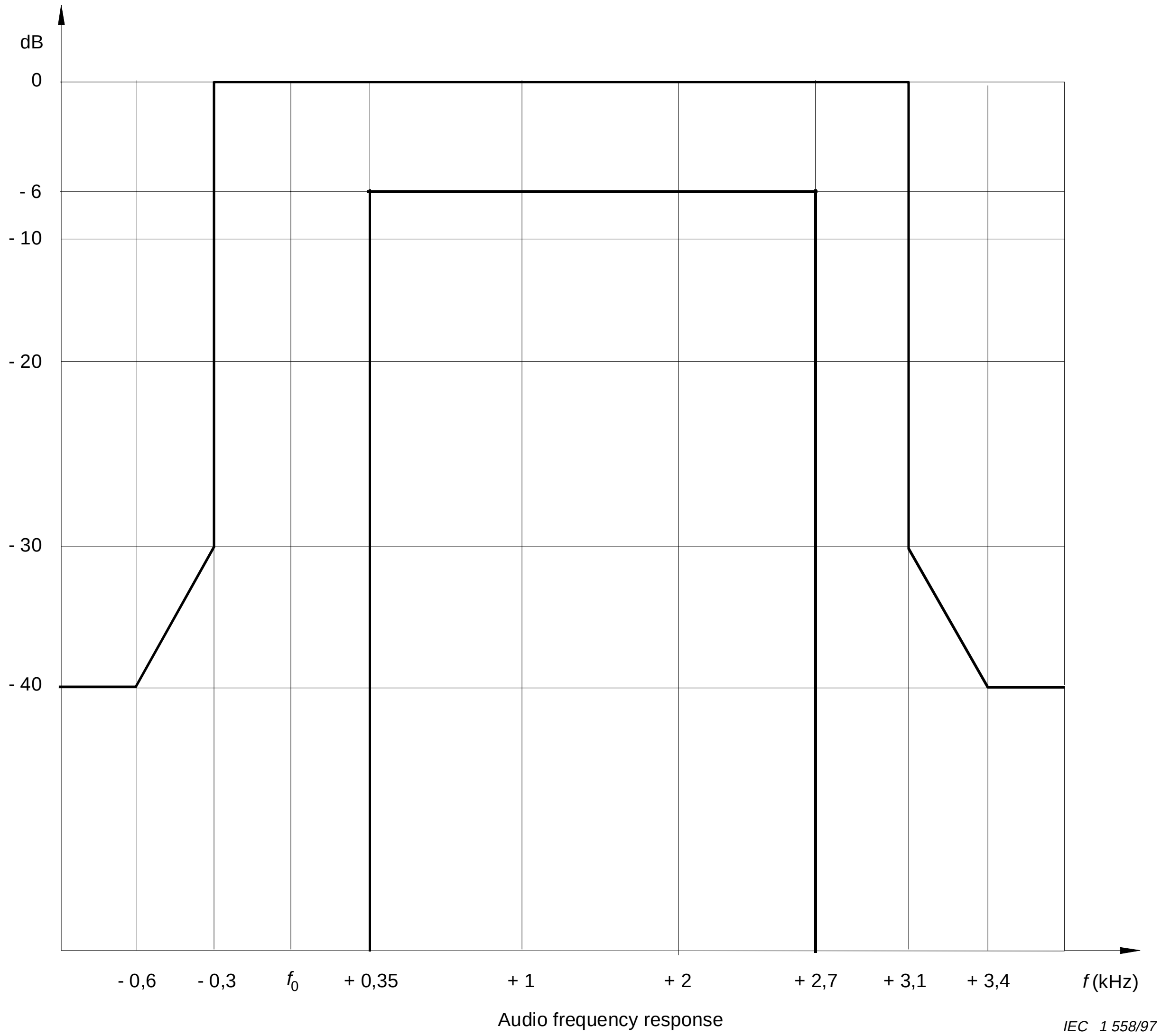

Figure 3 – Limits for audio frequency response

Annex A
(informative)

Relationship between bit error rate (BER) input and symbol error rate (SER) output

A.1 Introduction

The DSC signalling format contains check bits (bits 8, 9 and 10) in each symbol, time diversity repetition of each symbol and an error-check character at the end of the signalling format.

It is therefore to be expected that a given BER of for example 1 % at the input of the DSC decoder does not necessarily result in a symbol error rate of the same value (1 %) at the output of the DSC decoder.

The symbol error rate detected at the output of a DSC decoder depends not only on the actual BER in the signal applied to the input of the decoder, but also on the decoding algorithm implemented in the design of the DSC decoder. Recommendation ITU-R M.493-7 (annex 1, 1.6) states that the decoder should provide maximum utilization of the received signal, including the error-check character.

A.2 Measurement of the relationship between BER at the input of a DSC decoder and the symbol error rate at the output of the decoder

Telecom Denmark has carried out a substantial amount of measurements in order to clarify the relationship between BER at the input of a DSC decoder and the corresponding symbol error rate at the output of the DSC decoder.

A generator capable of producing different DSC calls has been connected to an independent DSC decoder. A known number of bit errors has been introduced in the DSC call applied to the DSC decoder, and the corresponding symbol error rate measured at the output of the DSC decoder.

For a fixed number of bit errors the call has been repeated 1 000 times, while the location of the fixed number of bit errors within the call has been varied randomly from call to call.

The resulting symbol error rate has been determined for each of the 1 000 calls. The mean value of the 1 000 symbol error rate measurements has been calculated and taken as representative for the relationship between the symbol error rate and the injected BER.

The full sequence of 1 000 calls has been carried out for zero bit error per call, thereafter for four bit errors per call, then for five bit errors per call, then six bit errors per call etc.

The whole series of measurements has then been repeated for different types of DSC call (distress call, all ship call, individual call) for DSC decoders (MF/HF as well as VHF) from two different manufacturers. Additionally, a somewhat reduced series of measurements has been carried out on a DSC decoder from a third manufacturer in order to verify that the results for that decoder were very close to the measurements for the first two decoders.

The condensed results are shown in figures A.1 to A.4.

A.3 Conclusion

The measurements show that a BER of 1 % corresponds to a symbol error rate of 0,7 % to 1,0 %.

Error rates generally decrease very quickly for increasing RF input signal levels.

The measurement uncertainty of RF signal levels is about ±0,75 dB.

In practice, a BER of 1 % at the input of a DSC decoder can be taken to correspond to a symbol error rate of 1 % at the output of the decoder.

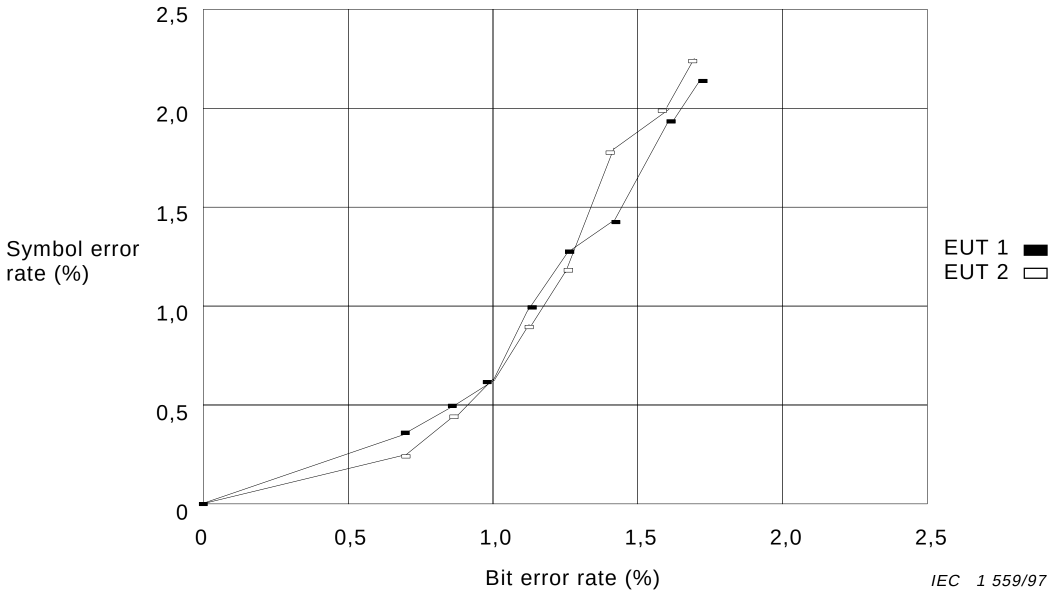

Figure A.1 – Symbol error rate (%) versus bit error rate (%) – Individual call

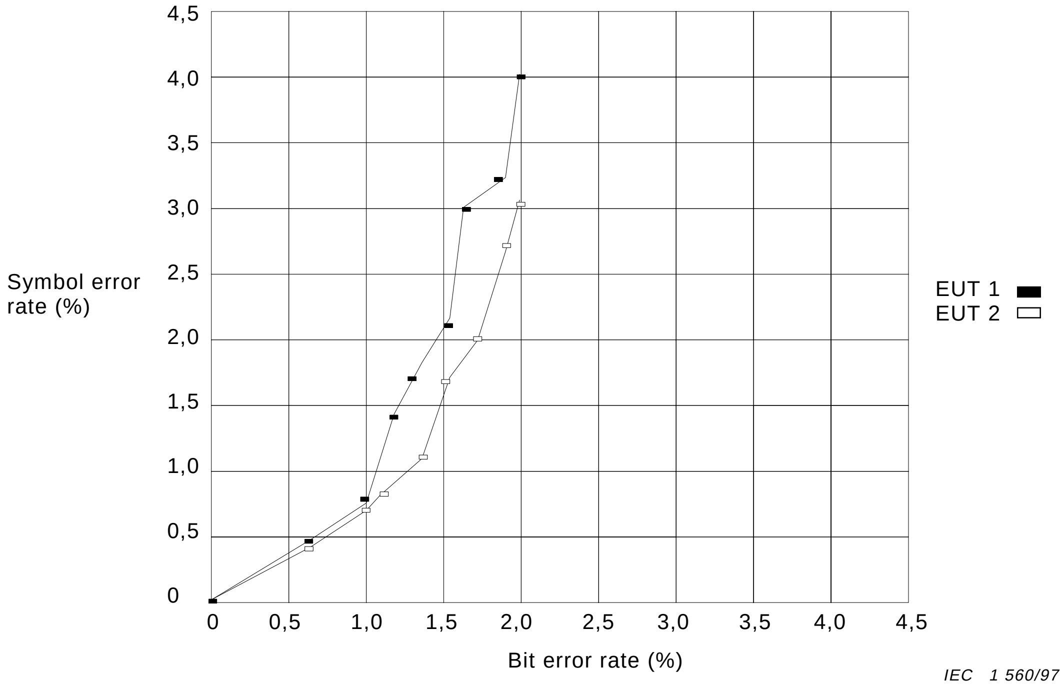

Figure A.2 – Symbol error rate (%) versus bit error rate (%) – Distress call

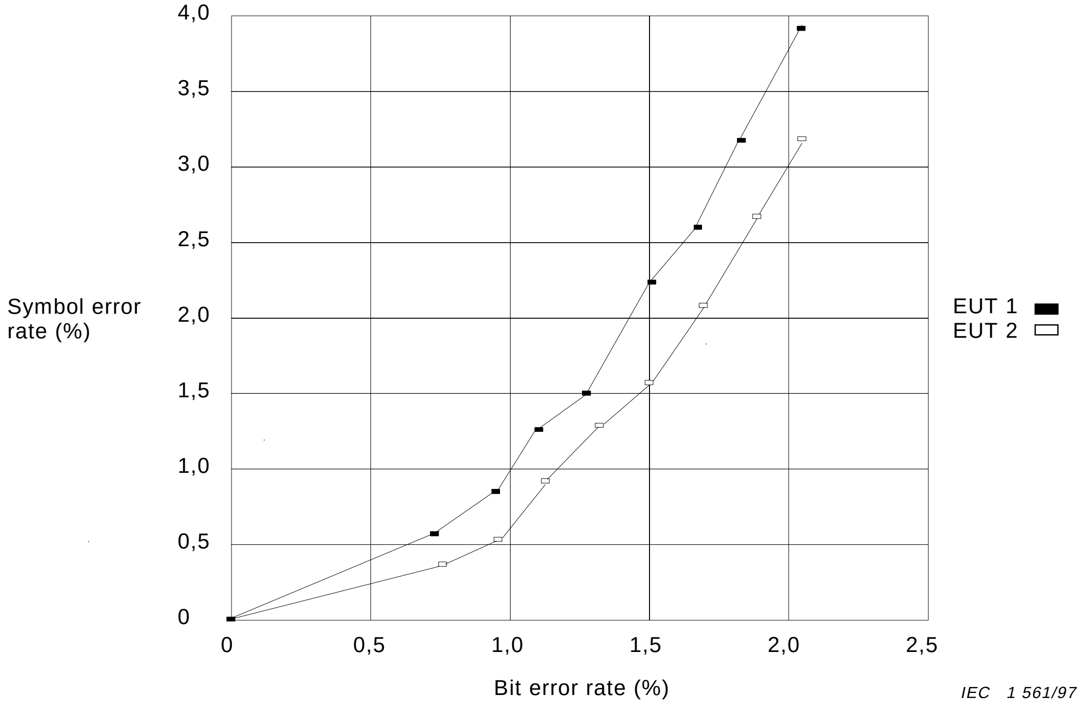

Figure A.3 – Symbol error rate (%) versus bit error rate (%) – All ship call

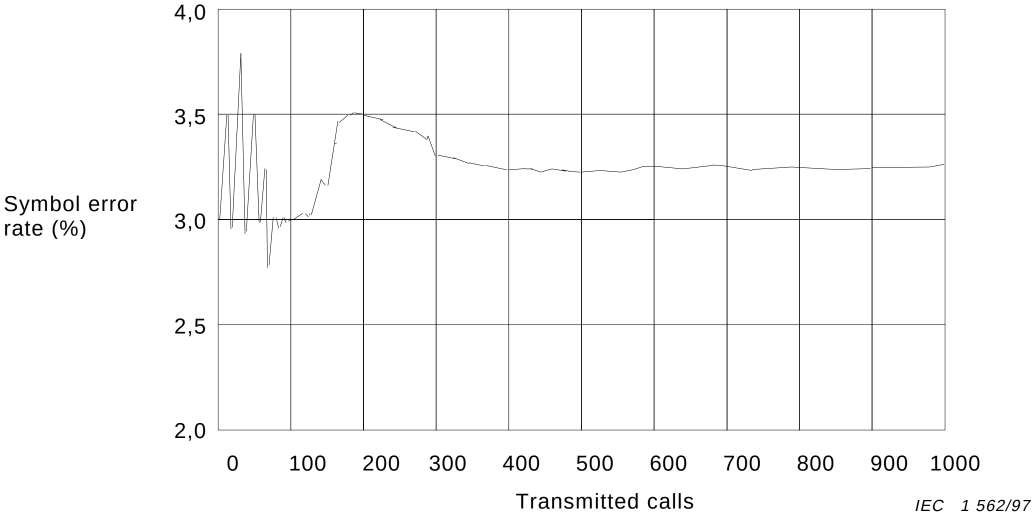

Figure A.4 – Symbol error rate (%) versus transmitted calls – Distress call – EUT 1

Annex B
(informative)

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Recommendation ITU-R M.332-4 (formerly CCIR Recommendation 332-4) (1992): *Selectivity of receivers.*

Annex C
(informative)

Delays in equipment and its effect on narrow band direct printing (NBDP) communication in the GMDSS using the protocol defined in Recommendation ITU-R M.625

C.1 Introduction

The system defined in Recommendation ITU-R M.625 requires that the transmit/receive equipment switches rapidly from one state to the other. In figure 1 to the Recommendation, the total cycle time is 450 ms, consisting of the transmission of an information block taking 210 ms and the reception of a control signal block of 70 ms; the rest of the time being available for propagation and equipment delays.

There are two problems with this system concerning short and long distance transmission paths.

C.2 Short distance

If the slave station is very close, less than 300 nautical miles, the propagation delay is about 2 ms for the round trip. Under these circumstances the master station may not have fully switched to receive by the time the first bit of the control signal arrives back. This effect is known, and coast stations often add some delay in the order of 10 ms (Gothenberg Radio) to ensure that on MF frequencies they can work local ships.

There is no mandated requirement in GMDSS for area A2 short distance NBDP communications.

C.3 Long distance

If the distance between the master and slave stations is very large the system runs out of time, the last bits of the control signal being lost to the master station attempting to send the next block.

If the slave station is at the antipodean point, the distance is 10 800 nautical miles, which in radio terms, allowing for reflections in the upper atmosphere, is approximately 11 000 nautical miles. As the speed of light is about 160 000 nautical miles per second, the one-way propagation delay is approximately 69 ms.

For the whole cycle time:

Information block	210 ms
Control signal	70 ms
2 x propagation delay	138 ms

This gives a total of 418 ms. Any extra delay must not be > 450 ms – 418 ms = 32 ms, or 16 ms at each end. Theoretically, this means that the antipodean point can be worked.

Long distance HF communications are not always that simple, the best path may be the "long path", and for GMDSS communications there should be at least 3 HF NBDP stations in each major ocean area, and as such there should be stations much closer than the antipodean case.

The specification limit has therefore been set at 16 ms for the sum of receive and transmit switching to ensure good working in all cases with an allowance for the decoding times in the modem equipment.

It is possible to design radio equipment with much faster switching times. This usually requires two synthesizers. Opening up the loop bandwidth can help but may compromise the phase noise which will subsequently affect the adjacent channel performance in NBDP mode, due to reciprocal mixing, and there will always be some delay due to the narrow bandwidth reception filter.

A radio equipment with these switching times is not the only part of the system and it is important that the corresponding modem is optimized for the transmitter pre-keying and equipment delay.

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- ☐ full text

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