INTERNATIONAL STANDARD

IEC 61097-8

First edition
1998-09

Global maritime distress and safety system (GMDSS) –

Part 8: Shipborne watchkeeping receivers for the reception of digital selective calling (DSC) in the maritime MF, MF/HF and VHF bands –

Operational and performance requirements, methods of testing and required test results

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

Partie 8: Récepteurs de veille de bord pour réception d'appel sélectif numérique (ASN) dans la gamme des ondes hectométriques, hectométriques et décamétriques, et métriques –

Exigences opérationnelles et de fonctionnement, méthodes d'essai et résultats exigibles

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For graphical symbols, and letter symbols and signs approved by the IEC for general use, readers are referred to publications IEC 60 027: *Letter symbols to be used in electrical technology*, IEC 60417: *Graphical symbols for use on equipment. Index, survey and compilation of the single sheets* and IEC 60 617: *Graphical symbols for diagrams.*

* See web site address on title page.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

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International Standard IEC 61097-8 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
80/191/FDIS	80/208/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.

A bilingual version of this standard may be issued at a later date.

GLOBAL MARITIME DISTRESS AND SAFETY SYSTEM (GMDSS) –

Part 8: Shipborne watchkeeping receivers for the reception of digital selective calling (DSC) in the maritime MF, MF/HF and VHF bands –

Operational and performance requirements, methods of testing and required test results

1 Scope

This part of IEC 61097 specifies the minimum requirements for shipborne receivers intended to be connected to an external installation, including a decoder for digital selective calling (DSC), and used as receivers for watchkeeping on DSC channels on board ships operating in the maritime mobile MF, MF/HF and VHF bands allocated in the Radio Regulations of the International Telecommunication Union (ITU) to the maritime mobile service, both in connection with distress and safety communication and in connection with general communication.

These requirements include the relevant provisions of the Radio Regulations and recommendations ITU-R M.489, and ITU-R M.541, and relevant provisions of resolutions A.694, A.803, A.804 and A.806 of the International Maritime Organization (IMO).

This standard also specifies technical characteristics, methods of testing and required test results for dedicated watchkeeping receivers for use with radio installations in the GMDSS as required by chapter IV of the International Convention for Safety of Life at Sea (SOLAS) 1974, as amended, and with which IEC 60945 is associated. When a requirement in this standard differs from IEC 60945, the requirement of this standard takes precedence.

This standard covers receivers with analogue or with digital DSC signal output interfaces or with both.

DSC watchkeeping receivers can be either fixed frequency receivers or, in MF/HF bands, scanning receivers.

They may be a separate equipment or be integrated with a DSC or radiotelephone equipment.

For integrated equipment this standard specifies the requirements and methods of testing of the DSC watchkeeping receivers only. The DSC equipment or radiotelephone shall comply with the requirements of the relevant standard, for example, IEC 61097-3 [3]*, IEC 61097-7 [4] and IEC 61097-9 [5] respectively.

NOTE – All requirements of this standard resulting from the above referenced IMO resolutions or ITU recommendations are identified by quoting the number of the IMO resolution or ITU recommendation and relevant paragraph in brackets following the requirement.

* Figures in square brackets refer to the bibliography given in annex C.

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 60417:1973, *Graphical symbols for use on equipment – Index, survey and compilation of the single sheets*

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

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

ISO 3791:1976, *Office machines and data processing equipment – Keyboard layouts for numeric applications*

ITU Radio Regulations:1997, as revised

ITU-R Recommendation M.489-2:1995, *Technical characteristics of VHF radiotelephone equipment operating in the maritime mobile service in channels spaced by 25 kHz*

ITU-R Recommendation M.493-9:1997, *Digital selective-calling system for use in the maritime mobile service*

ITU-R Recommendation M.541-8:1997, *Operational procedures for the use of digital selective-calling (DSC) equipment in the maritime mobile service*

ITU-T Recommendation E.161:1993, *Arrangement of digits, letters and symbols on telephones and other devices that can be used for gaining access to a telephone network*

ITU-R Recommendation SM.332-4:1994, *Selectivity of receivers*

ITU-T Recommendation V.11:1996, *Electrical characteristic for balanced double-current interchange circuits operating at signalling rates up to 10 Mbit/s*

International Convention for the Safety of Life at Sea (SOLAS) 1974, as amended

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

IMO Resolution A.803:1995, *Performance standards for shipborne VHF radio installations capable of voice communications and digital selective calling*

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

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

ETR 028:1994, *Radio Equipment and Systems (RES) – Uncertainties in the measurement of mobile radio equipment characteristics*

3 Definitions and abbreviations

3.1 Definitions

For the purpose of this standard, the following definitions apply:

3.1.1
assigned frequency
the centre of the frequency band assigned to a station

3.1.2
continuous watch
the capability of receiving DSC calls not being interrupted other than for brief intervals when the ship's receiving capability is impaired or blocked by its own communications or when the facilities are under periodical maintenance or checks (SOLAS/IV.2.1.2)

3.1.3
F1B
frequency modulation with digital information, without a subcarrier for automatic reception

3.1.4
J2B
single sideband with digital information, with the use of a modulating subcarrier, with the carrier suppressed to at least 40 dB below peak envelope power

3.1.5
G2B
phase-modulation with digital information, with a subcarrier for automatic reception

3.1.6
performance check
a check of calling sensitivity

3.2 Abbreviations

For the purpose of this standard, the following abbreviations apply:

a.c.	Alternating current
BER	Bit error rate
d.c.	Direct current
DSC	Digital selective calling
e.m.f.	Electromotive force
EMC	Electromagnetic compatibility
EMI	Electromagnetic immunity
ETR	ETSI technical report
ETS	European telecommunications standard
ETSI	European Telecommunications Standards Institute
EUT	Equipment under test
FSK	Frequency shift keying
GMDSS	Global maritime distress and safety system
IEC	International Electrotechnical Commission
IMO	International Maritime Organisation
ISO	International Organization for Standardisation
ITU	International Telecommunication Union
ITU-R	ITU Radiocommunication Sector
ITU-T	ITU Standardization Sector
MF	Medium frequency
MF/HF	Medium and high frequency
RF	Radiofrequency
r.m.s.	Root mean square
RR	Radio regulations
S/N	Signal-to-noise ratio
SER	Symbol error rate
SOLAS	Safety of life at sea
VHF	Very high frequency

4 General and operational requirements

4.1 General

The equipment, in addition to meeting the requirements of the Radio Regulations, the relevant ITU recommendations, the IMO performance standards and general requirements set out in IMO resolution A.694 and detailed in IEC 60945, shall comply with the following requirements and with the technical requirements contained in clause 5 of this standard (A.803/1, A.804/A.1, A.806/A.1).

Requirements contained in clause 4 need not be verified by measurements. The manufacturer shall declare that compliance with these requirements is achieved and shall provide relevant documentation.

The manufacturer shall also declare the composition of the equipment and the relevant category of IEC 60945 for each unit.

4.2 Construction

4.2.1 General

The equipment shall be so constructed that it is capable of:

– keeping continuous watch on DSC channels (A.803/2.4.6, A.804/A.2.4.6, A.806/A.2.4.7);

– being operated readily and in accordance with the requirements of this standard.

4.2.2 Design

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

The equipment shall be designed for continuous operation.

4.2.3 Accessibility

All parts of the equipment that are subject to inspection and maintenance adjustments shall be easily accessible (A.694/8.2).

Components shall be easily identifiable either by markings within the equipment, or with the aid of technical descriptions.

4.2.4 Calibration and maintenance

The equipment shall be so constructed that its main modules can be replaced easily and put into operation without elaborate calibration or readjustment (A.694/8.1).

4.2.5 Antenna static protection

In order to provide protection against damage due to static voltages that 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.

4.2.6 Digital input panels

Where a digital input panel with the digits 0 to 9 is provided, the digits preferably shall be arranged to conform with recommendation ITU-T E.161. However, where an alphanumeric keyboard layout, as used on office machinery and data processing equipment, is provided, the digits 0 to 9 may, alternatively, be arranged to conform with ISO 3791 (A.694/3.6).

4.3 Controls and indicators

4.3.1 General

The number of operational controls, their design and manner of functioning, location, arrangement and size should provide for simple, quick and efficient operation. The controls shall be arranged in a manner which minimizes the chance of inadvertent activation (A.694/3.1).

All operational controls shall permit normal adjustments to be easily performed (A.694/3.2).

The user shall not have access to any control which may impair the technical characteristics of the equipment if wrongly set.

4.3.2 Identification

All operational controls and indicators shall be easy to identify and read from the position at which the equipment is normally operated (A.694/3.2).

The controls and indicators shall be identified in English. Symbols as specified in IEC 60417 may be used in addition to the identification in English.

4.3.3 Protection against possible maladjustment

Controls not required for normal operation shall not be readily accessible (A.694/3.2).

Operational controls, the inadvertent exercise of which could switch off the equipment, lead to its performance degradation or to false indications not obvious to the operator, shall be protected especially against unintentional operation.

4.3.4 Light sources

Equipment with controls and indicators shall be provided with adequate adjustable illumination to enable identification of controls and facilitate reading of indicators at all times. Means shall be provided for dimming the output of any equipment light source (A.694/3.3).

4.3.5 Operation

The design of the equipment shall be such that misuse of the controls shall not cause damage to the equipment or injury to personnel (A.694/3.4).

4.4 Software

Facilities shall be provided to protect all operational software incorporated in the equipment.

Any software required in an equipment to facilitate operation, including that for its initial activation/reactivation, shall be permanently installed within the equipment, in such a way that it is not possible for the user to have access to this software.

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 non-automatic recoverable failure.

4.5 Memory

Pre-programmed DSC distress calling frequencies and information inherent to the operation of the equipment shall be stored in non-volatile devices.

If the equipment contains information in operator programmable memory devices, such devices shall be protected from interruptions in the power supply up to at least 10 h duration.

4.6 Interfaces

4.6.1 DSC signal output – analogue interface

For equipment designed for analogue DSC signal output to an external DSC decoder, the audio frequency signal output shall have an impedance of 600 Ω, balanced and free of earth, and the closed circuit level shall be adjustable to any r.m.s. voltage between 0,245 V and 2,450 V (0 dBm ± 10 dB).

The higher frequency corresponds to the B-state and the lower frequency corresponds to the Y-state of the signal elements.

4.6.2 DSC signal output – digital interface

For equipment designed for binary signal output to an external DSC decoder, the logic level of the digital signal output shall be compatible with recommendation ITU-T V.11.

The B-state shall be the logic “0”, and the Y-state shall be the logic “1”.

4.6.3 Operational interfaces

Where provided:

– interfaces for stop and start of the scanning sequence of scanning receivers shall comply with recommendation ITU-T V.11;

– interfaces for frequency control or read-out of scanning receivers shall comply with IEC 61162-1.

Additional interfaces may be provided but connection of, or failure within, any external circuits shall not degrade the performance of the equipment (A.694/3.5).

4.7 Marking and identification

Each unit of the equipment shall be marked externally with the following information which, where practicable, should be clearly visible in the normal installed position:

– identification of the manufacturer;

– equipment type number or model identification under which it was type tested;

– serial number of the unit (A.694/9);

– details of the power supply from which the equipment is intended to operate.

Alternatively, the marking may be presented on a display on equipment start-up.

The title and version of the installed software system shall be either marked or displayed on command on the equipment.

When the marking and the title and version of the software are shown only on the display, such information shall also be included in the equipment manual.

The DSC frequency or channel to which the equipment is tuned or programmed shall be clearly indicated. For programmable scanning receivers, read-out or print-out on the receiver controller shall be used.

4.8 Instructions

Adequate information shall be provided to enable the equipment to be properly operated and maintained.

Operating and servicing manuals shall:

– at least be written in English;

– identify the category (protected from or exposed to the weather) of the equipment or units to which they refer;

– in the case of equipment so designed that fault diagnosis and repair down to component level are practicable, provide full circuit diagrams, component layouts, a component parts list;

– in the case of equipment containing complex modules in which fault diagnosis and repair down to component level are not practicable, contain sufficient information to enable a defective complex module to be located, identified and replaced. Other modules and those discrete components which do not form part of modules shall also meet the requirements above (A.694/8.3).

4.9 Warming-up period

The equipment shall be operational and shall meet the requirements of this standard 1 min after switching on (A.803/5, A.804/C.5, A.806/C.5).

4.10 Safety precautions

4.10.1 Excessive current and voltage

Means shall be incorporated for the protection of equipment from the effects of excessive current and voltage and accidental reversal of the power supply polarity or phase sequence (A.694/4.2).

4.10.2 Earthing

Means shall be provided for earthing exposed metallic parts of the equipment, but the equipment shall not cause any terminal of the source of electrical energy to be earthed (A.694/7.2).

4.10.3 Protection

As far as practicable, accidental access to dangerous voltages shall be prevented. All parts and wiring in which the direct or alternating voltages or both (other than radiofrequency voltages) combine to give a peak voltage greater than 50 V, shall be protected against accidental access and shall be isolated automatically from all sources of electrical energy when the protective covers are removed. Alternatively, the equipment shall be so constructed that access to such voltages may only be gained after having used a tool for this purpose, such as a spanner or screwdriver, and warning labels shall be prominently displayed both within the equipment and on protective covers.

4.11 Compass safe distance

The compass safe distance to a standard or steering magnetic compass shall be stated on the equipment or in the manual (A.694/6.3).

The determination of the compass safe distance shall be performed in accordance with IEC 60945.

5 Technical requirements

5.1 Durability and resistance to environmental conditions

The equipment shall be capable of continuous operation under the conditions of various sea states, vibration, humidity and of temperature likely to be experienced in ships (A.694/5).

5.2 Protection of the antenna input circuit

The receiver shall not suffer damage when an unmodulated radiofrequency signal at an input level of 30 V r.m.s. at any frequency in the range 100 kHz to 27,5 MHz is applied to its antenna input terminal for a period of 15 min.

5.3 Frequency bands and channels

The equipment can be designed as a single-frequency receiver, as a multiple-frequency receiver or as a scanning receiver in one or more of the frequency bands:

MF: 1 605 kHz to 4 000 kHz;

HF: 4 MHz to 27,5 MHz;

VHF: 156 MHz to 174 MHz.

MF and HF DSC frequencies shall be designated in terms of the assigned frequency (A.804/B.1.2, A.806/B.1.2).

On MF and HF DSC calling frequencies for distress, urgency and safety calling are different from those for general communication calling.

The MF and HF DSC distress calling frequencies are:

– 2 187,5 kHz; 4 207,5 kHz; 6 312 kHz; 8 414,5 kHz; 12 577 kHz and 16 804,5 kHz (M.541/A5.1).

For general communication the international MF calling frequency shore-to-ship and ship-to-ship is 2 177 kHz and ship-to-shore is 2 189,5 kHz.

For general communication the international HF calling frequencies shore-to-ship first choice are:

– 4 219,5 kHz; 6 331 kHz; 8 436,5 kHz; 12 657 kHz; 16 903 kHz; 19 703,5 kHz; 22 444 kHz and 26 121 kHz (M.541/A5.2.2).

For general communication the international HF calling frequencies ship-to-ship and ship-to-shore first choice are:

– 4 208 kHz; 6 312,5 kHz; 8 415 kHz; 12 577,5 kHz; 16 805 kHz; 18 895,5 kHz; 22 374,5 kHz; and 25 208,5 kHz (M.541/A5.2.1).

Additional frequencies allocated to coast stations are:

– 4 220 kHz; 6 331,5 kHz; 8 437 kHz; 12 657,5 kHz; 16 903,5 kHz; 19 704 kHz; 22 444,5 kHz; 26 121,5 kHz;

– 4 220,5 kHz; 6 332 kHz; 8 437,5 kHz; 12 658 kHz; 16 904 kHz; 19 704,5 kHz; 22 445 kHz; 26 122 kHz (M.541/A5.2.2).

Additional frequencies allocated to ship stations are:

– 4 208,5 kHz; 6 313 kHz; 8 415,5 kHz; 12 578 kHz; 16 805,5 kHz; 18 899 kHz; 22 375 kHz; 25 209 kHz;

– 4 209 kHz; 6 313,5 kHz; 8 416 kHz; 12 578,5 kHz; 16 806 kHz; 18 899,5 kHz; 22 375,5 kHz; 25 209,5 kHz (M.541/A5.2.1).

For general communication calling only, other MF and HF working channels may also be used (M.541/A5.3).

Watchkeeping receivers for the MF DSC frequency for distress, urgency and safety calling shall be single-frequency receivers for 2 187,5 kHz (A.804/A.2.4.6).

MF and MF/HF scanning receivers shall be designed for scanning of up to six frequencies for either DSC distress calling only, or for DSC general communication calling only (A.806/A.2.4.7).

On VHF the calling channel for distress, urgency and safety calling as well as for general communication calling is channel 70 (M.541/A4.1.1).

Watchkeeping receivers for VHF distress, urgency and safety calling frequencies shall be single-channel receivers set to channel 70 (A.803/2.4.6).

For general communication calling only, VHF watchkeeping receivers may be switched to other channels of appendix S18 of the Radio Regulations (M.541/A5.3).

5.4 Mode of reception

Equipment for reception of MF and HF DSC transmissions shall provide for classes of emission F1B or J2B (A.804/C.1.3, A.806/C.1.3).

Equipment for reception of VHF DSC transmissions shall provide for class of emission G2B (see RR appendix 19) (A. 803/3.4).

5.5 Scanning receivers

5.5.1 Scanning sequence

An MF/HF scanning receiver shall be able to complete a scanning sequence within 2 s (A.806/A.2.4.7).

5.5.2 Scanning frequencies

Scanning watchkeeping receivers shall be dedicated to either scan DSC distress frequencies or to scan DSC frequencies for general communication. It shall not be possible to have both DSC distress frequencies and DSC frequencies for general communication in one scanning sequence.

5.5.2.1 DSC distress frequencies

Scanning watchkeeping receivers for MF/HF DSC distress frequencies shall scan the frequencies 2 187,5 kHz and 8 414,5 kHz and at least one other HF DSC distress frequency listed in 5.3 up to a total of six frequencies in the scanning sequence (SOLAS IV/10.2.2).

5.5.2.2 DSC frequencies for general communication

Scanning watch receivers for MF and HF DSC frequencies for general communication may scan any frequency up to a total of six frequencies in the scanning sequence.

5.5.3 Stop/start of scanning

The scanning receiver shall be provided with means for stop and start of the scanning under the control of an external DSC equipment. Such control may be provided by either:

– a stop/start signal in accordance with recommendation ITU-T V.11. The stop signal shall be logic 0 and the start signal shall be logic 1; or
– by direct frequency commands in accordance with IEC 61162-1, or both.

5.5.4 Frequency information

The selected receiver frequency shall be clearly identifiable (A.806/C.1.2).

Means shall be provided for automatic transfer of information of the frequency or channel on which the scanning has stopped for use and display in an external installation (normally a DSC equipment). The interface for such transfer shall be in accordance with IEC 61162-1.

5.6 Calling sensitivity

The sensitivity of the receiver shall be such as to obtain an output character error rate of 10^{-2} or less for an input signal of +5 dBμV (e.m.f.) on MF and 0 dBμV (e.m.f.) on HF and VHF (A.804/C.3, A.806/C.3).

5.7 Adjacent channel selectivity

The adjacent channel selectivity shall be 40 dB for MF/HF and 70 dB for VHF.

5.8 Co-channel rejection

The co-channel rejection ratio shall be between –10 dB and 0 dB.

5.9 Intermodulation response

The intermodulation response for MF and HF equipment shall be such as to obtain a specified BER at a level of +70 dBμV for each of the two unwanted input signals.

The intermodulation response ratio for VHF equipment shall be 65 dB (M.489/1.3.4).

5.10 Interference rejection, spurious response and blocking immunity

The interference rejection for MF and HF equipment shall be such as to obtain a specified BER at a level of the unwanted input signal of +60 dBμV.

The spurious response immunity for VHF equipment shall be 70 dB (M.489/1.3.3).

The blocking level shall be not less than +90 dBμV for MF/HF equipment and +93 dBμV for VHF equipment.

5.11 Dynamic range

The dynamic range shall be 80 dB for MF/HF equipment and 100 dB for VHF equipment.

5.12 Conducted spurious emissions into the antenna

Conducted spurious emissions into the antenna shall not exceed 2 nW (M.489/1.3.5).

5.13 Frequency stability

For MF/HF equipment, the receiver frequency shall at all times remain within 10 Hz of the required frequency following the warming-up period (A.804/C.2, A.806/C.2).

6 General test conditions

6.1 General

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

The equipment under test (EUT), when integrated with a DSC equipment or a radiotelephone, shall be provided with an accessible test point at the watchkeeping receiver analogue or digital signal output.

6.2 Test power source

During conformance testing the equipment shall be supplied from a test power source, capable of producing normal and extreme test voltages as specified in 6.3.2 and 6.4.2.

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

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

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

6.3 Normal test conditions

6.3.1 Normal temperature and humidity

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

– temperature: +15 °C to +35 °C;

– relative humidity: 20 % to 75 %.

6.3.2 Normal test power source

6.3.2.1 Mains voltage and frequency

The normal test voltage for equipment to be connected to the a.c. mains shall be the declared voltage and frequency or any one of the declared voltages and frequencies for which the equipment was designed.

The frequency of the test power supply shall be 50 Hz ± 1 Hz.

6.3.2.2 Secondary battery power sources

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

6.3.2.3 Other power sources

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

6.4 Extreme test conditions

6.4.1 Extreme temperature

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

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

6.4.2 Extreme values of test power source

6.4.2.1 Mains voltage and mains frequency

The extreme test voltages for equipment to be connected to an a.c. mains supply shall be the nominal mains voltage ±10 %. The extreme frequency of the test power supply shall be 50 Hz ± 1 Hz.

6.4.2.2 Secondary battery power sources

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

6.4.2.3 Other power sources

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

6.5 Application of test signals to the receiver

6.5.1 Arrangement

For the purpose of conformance testing, the receiver shall meet the requirements of this standard when connected to sources of test signals so that the impedance presented to the receiver input is 50 Ω resistive. In the frequency range 1 605 kHz to 4 000 kHz, at the request of the manufacturer, a network consisting of a 10 Ω resistor in series with a 250 pF capacitor may be used.

The arrangement used shall be stated in the test report.

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

6.5.2 Sources

Sources of test signals for application to the receiver input shall be connected through a network as specified in 6.5.1. This requirement shall be met irrespective of whether one, two or more test signals are applied to the receiver simultaneously. In the case of multiple test signals, steps shall be taken to prevent any undesirable effects due to interaction between the signals in the generators or other sources.

6.5.3 Levels

The levels of test signals shall be expressed in terms of the e.m.f. that would exist at the output terminals of the source, including the associated network referred to in 6.5.1.

6.6 Choice of testing frequencies

The testing frequencies shall be for:

– MF watchkeeping receivers: 2 187,5 kHz;
– MF/HF scanning receivers: 8 414,5 kHz;
– VHF watchkeeping receivers: 156,525 MHz (channel 70).

6.7 Test signals

Except where otherwise stated, radiofrequency test signals applied to the receiver input shall be as described in the following subclauses.

A standard test signal shall simulate the DSC modulation specified in recommendation ITU-R M.493 and shall be of sufficient duration for the measurements to be performed, or it shall be possible to repeat it without interruption as long as necessary to make the measurements.

6.7.1 Standard test signal No. 1

Standard test signal No. 1 for MF and HF DSC watchkeeping receivers shall be an FSK-modulated signal with a nominal radiofrequency as specified in 6.6. The modulating signal shall have a frequency shift of ±85 Hz keyed by a square-wave signal with a frequency of 50 Hz simulating a continuous dot pattern. Phase-coherent switching between B-state and Y-state is preferable.

6.7.2 Standard test signal No. 2

Standard test signal No. 2 for VHF DSC watchkeeping receivers shall be a phase-modulated signal with a nominal radiofrequency assigned for VHF channel 70. The modulating signal shall have a centre frequency of 1 700 Hz and a frequency shift of ±400 Hz keyed by a square-wave signal with a frequency of 600 Hz simulating a continuous dot pattern. The modulation index shall be 2. Phase coherent switching between B-state and Y-state is preferable.

6.8 Measurement of bit error rate (BER)

For tests on receivers with digital output, all measurements shall be performed by measuring the BER at the digital output.

For tests on receivers with analogue output the measurement shall be performed by using a linear FSK discriminator connected to the analogue output. All receiver measurements shall then be made by measuring the BER at the discriminator output.

For further guidance, see annex A.

6.9 Measurement uncertainty and interpretation of the measuring results

6.9.1 Measurement uncertainty

Maximum values of absolute measurement uncertainties shall be:

– RF frequency: $\pm 1 \times 10^{-7}$;
– RF level: ±0,75 dB;
– audio output power: ±0,5 dB;
– sensitivity of receiver: ±3 dB;
– conducted emission of receiver: ±3 dB;
– two-signal measurement: ±4 dB;
– three-signal measurement: ±3 dB;
– radiated emission of receiver: ±6 dB.

For the test methods according to this standard, the uncertainty figures are valid to a confidence level of 95 % calculated according to the methods described in ETR 028.

6.9.2 Interpretation of measurement results

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

– the measured value related to the corresponding limit will be used to decide whether an equipment meets the requirements of this standard;
– the measurement uncertainty value for the measurement of each parameter shall be included in the test report;
– for each measurement, the recorded value of the measurement uncertainty shall be equal to or lower than the values in 6.9.1.

7 Environmental tests

7.1 Procedure

Environmental tests shall be carried out before tests of the same equipment are performed, with respect to the other requirements of this standard.

Unless otherwise stated, the equipment shall be connected to an electrical power source during the periods for which it is specified that electrical tests shall be carried out. These tests shall be performed using the normal test voltage.

7.2 Performance check

A performance check shall be a test of the calling sensitivity with the receiver connected as specified in 6.5:

– for MF equipment with standard test signal No. 1 applied at an input level of +11 dBµV;
– for HF equipment with standard test signal No. 1 applied at an input level of +6 dBµV;
– for VHF equipment with standard test signal No. 2 applied at an input level of +6 dBµV.

The BER shall be less than 10^{-2}.

7.3 Vibration tests

7.3.1 Objective

These tests determine the ability of equipment to withstand vibration without resulting in mechanical weakness or degradation in performance. They simulate the effect of vibration induced in a ship's hull by its propeller and machinery. This is generally at frequencies of up to 13 Hz and predominantly vertical. The tests at higher frequencies simulate the effect of slamming which occurs in irregular stormy seas and is predominantly horizontal. The tests do not simulate the effect of regular seas giving the translational components of surging, swaying and heaving, and the corresponding rotational components of rolling, pitching and yawing which generally produce accelerations too small to be of consequence to electronic equipment.

7.3.2 Method of measurement

The EUT, complete with any shock and vibration absorbers with which it is provided, shall be clamped to the vibration table by its normal means of support and in its normal attitude. The EUT may be resiliently suspended to compensate for weight not capable of being withstood by the vibration table. Provision may be made to reduce or nullify any adverse effect on EUT performance which could be caused by the presence of an electromagnetic field due to the vibration unit.

The equipment shall be subjected to sinusoidal vertical vibration at all frequencies between:

– 2 Hz to 5 Hz and up to 13,2 Hz with an excursion of ±1 mm ± 10 % (7 m/s^2 maximum acceleration at 13,2 Hz);
– above 13,2 Hz and up to 100 Hz with a constant maximum acceleration of 7 m/s^2.

The frequency sweep rate shall be slow enough to allow the detection of resonances in any part of the EUT.

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

Performance check(s) (see 7.2) shall be carried out at least once during each endurance test period, and once before the end of each endurance test period.

The procedure shall be repeated with vibration in each of two mutually perpendicular directions in the horizontal plane.

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

7.3.3 Results required

The equipment shall meet the requirements of the performance check.

There shall be no visible harmful deterioration of the equipment.

7.4 Temperature tests

The immunity against the effects of temperature is the ability of the equipment to maintain the specified mechanical and electrical performance after the following tests have been carried out.

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

7.4.1 Dry heat functional test

NOTE – This test may be combined with the tests covered by 8.1 or 9.1 as applicable.

7.4.1.1 Objective

This test determines the ability of equipment to be operated at high ambient temperatures and to operate through temperature changes. The reasonable maximum air temperature likely to be encountered over the sea is +32 °C and the maximum solar gain at sea is +23 °C giving +55 °C as the maximum temperature likely to be encountered by ships at sea.

7.4.1.2 Method of measurement

The EUT shall be placed in a chamber at normal room temperature and relative humidity. The EUT and, if appropriate, any climatic control devices with which it is provided shall then be switched on. The temperature shall then be raised to and maintained at +55 °C ± 3 °C.

At the end of a soak period of 10 h to 16 h at +55 °C ± 3 °C, the EUT shall be subjected to the performance check of 8.2 or 9.1 as applicable.

The temperature of the chamber shall be maintained at +55 °C ± 3 °C during the whole test period.

At the end of the test, the EUT shall be returned to normal environmental conditions or to those required at the start of the next test.

7.4.1.3 Results required

The equipment shall meet the requirements of the performance check.

7.4.2 Damp heat

7.4.2.1 Objective

This test determines the ability of equipment to be operated under conditions of high humidity. A single cycle is used with an upper temperature limit of +40 °C which is the maximum that occurs in the earth's surface atmosphere with a relative humidity of 95 %.

7.4.2.2 Method of measurement

The EUT shall be placed in a chamber at normal room temperature and relative humidity. The temperature shall then be raised to +40 °C ± 2 °C, and the relative humidity raised to 93 % ± 3 % over a period of 3 h ± 0,5 h. These conditions shall be maintained for a period of 10 h to 16 h.

Any climatic control devices provided in the EUT may be switched on at the conclusion of this period.

The EUT shall be switched on 30 min later, or after such period as agreed by the manufacturer, and shall be kept operational for at least 2 h during which period the EUT shall be subjected to the performance check.

The temperature and relative humidity of the chamber shall be maintained as specified during the whole test period.

At the end of the test period and with the EUT still in the chamber, the chamber shall be brought to room temperature in not less than 1 h.

At the end of the test the EUT shall be returned to normal environmental conditions, or to those required at the start of the next test.

7.4.2.3 Results required

The equipment shall meet the requirement of the performance check.

7.4.3 Low temperature

NOTE – This test may be combined with the tests required by 8.1 or 9.1 as applicable.

7.4.3.1 Objective

These tests determine the ability of equipment to be operated at low temperatures. They also allow equipment to demonstrate an ability to start up at low ambient temperatures.

7.4.3.2 Method of measurement

The EUT shall be placed in a chamber at normal room temperature and relative humidity. The temperature shall then be reduced to and maintained at –15 °C ± 3 °C, for a period of 10 h to 16 h. Any climatic control devices provided in the EUT may be switched on at the conclusion of this period.

The EUT shall be switched on 30 min later, or after such a period as agreed by the manufacturer, and shall be kept operational for at least 2 h, during which period the EUT shall be subjected to the performance check of 8.2 or 9.1 as applicable.

The temperature of the chamber shall be maintained at –15 °C ± 3 °C during the whole test period.

At the end of the test the EUT shall be returned to normal environmental conditions, or to those required at the start of the next test.

7.4.3.3 Results required

The equipment shall meet the requirements of the performance check of 8.2 or 9.1 as applicable.

7.5 Corrosion test

7.5.1 General

This test shall be waived where the manufacturer is able to produce evidence that the components, materials and finishes employed in the equipment satisfy the requirements of this subclause.

7.5.2 Objective

This test determines the ability of an equipment to be exposed to a salt-laden atmosphere without physical degradation. The cyclic nature of the test produces an acceleration of effects compared with service conditions.

7.5.3 Method of measurement

The EUT shall be placed in a chamber and sprayed with a salt solution for 2 h at normal temperature. The salt solution shall be prepared by dissolving 5 ± 1 parts by weight of sodium chloride (NaCl) in 95 parts by weight of distilled or de-mineralized water.

At the end of the spraying period the EUT shall be placed in a chamber, which shall be maintained at a temperature of 40 °C ± 2 °C and a relative humidity between 90 % and 95 % for a period of seven days.

The EUT shall be subjected to a test comprising four spraying periods, each of 2 h duration, with a storage period of seven days after each.

At the conclusion of the test the EUT shall be inspected with the naked eye without magnification. The EUT shall then be subjected to the performance check.

7.5.4 Results required

There shall be no undue deterioration or corrosion of metal parts.

The requirement of a performance check shall be met.

8 MF/HF watchkeeping receiver

8.1 Calling sensitivity

8.1.1 Objective

To determine the maximum usable sensitivity as the minimum level of the signal (e.m.f.) at the nominal frequency of the receiver which, when applied to the receiver input with a standard test signal, will produce a specified BER.

8.1.2 Method of measurement

The arrangements for applying the test signals shall be in accordance with 6.5.

Standard test signal No. 1 shall be applied:

– for MF the input level shall be +5 dBμV under normal and +11 dBμV under extreme test conditions;

– for HF the input level shall be 0 dBμV under normal and +6 dBμV under extreme test conditions.

The BER in the output shall be determined as described in 6.8.

The measurements shall be carried out under normal test conditions (see 6.3) and under extreme test conditions (6.4.1 and 6.4.2 applied simultaneously). The measurements under extreme test conditions may be carried out during environmental tests (see 7.4.1 and 7.4.3).

The measurement shall be repeated at the nominal input frequency ±10 Hz under normal test conditions.

8.1.3 Results required

The BER shall be equal to or less than $10^{-2.}$

8.2 Adjacent channel selectivity

8.2.1 Objective

To determine the capability to receive a wanted modulated signal without exceeding a specified BER due to the presence of an unwanted modulated signal in channels adjacent to that of the wanted signal. The adjacent channel selectivity is expressed as the ratio of the levels at the receiver input of an unwanted signal to a wanted signal which results in a specified BER.

8.2.2 Method of measurement

The arrangements for applying the test signals shall be in accordance with 6.5.

The wanted RF signal shall be standard test signal No. 1 with an input level of +20 dBμV.

The unwanted signal shall be an unmodulated signal at the frequency +500 Hz and then –500 Hz relative to the nominal frequency of the receiver (centre frequency). The level of the unwanted signal shall be +60 dBμV.

The BER in the output shall be determined as described in 6.8.

8.2.3 Results required

The BER shall be equal to or less than 10^{-2}.

8.3 Co-channel rejection

8.3.1 Objective

To determine the capability to receive a wanted modulated signal without exceeding a specified BER due to the presence of an unwanted modulated signal, both signals being at the nominal frequency of the receiver.

8.3.2 Method of measurement

The arrangements for applying the test signals shall be in accordance with 6.5.

The wanted signal shall be standard test signal No. 1 at an input level of +20 dBμV.

The unwanted signal shall be unmodulated. The level of the unwanted signal shall be +14 dBμV.

Both input signals shall be at the nominal frequency of the receiver.

The BER in the output shall be determined as described in 6.8.

8.3.3 Results required

The BER shall be equal to or less than 10^{-2}.

8.4 RF intermodulation response

8.4.1 Objective

To determine the capability to reject intermodulation products originating from two or more (generally unwanted) signals at specified levels simultaneously present in a non-linear circuit.

8.4.2 Method of measurement

The arrangements for applying the test signals shall be in accordance with 6.5.

The wanted signal shall be standard test signal No. 1 at an input level of +20 dBμV.

The two unwanted signals shall be applied, both unmodulated and at the same level of +70 dBμV. Neither of the two signals shall be at a frequency nearer to the wanted signal than 30 kHz.

NOTE – Frequency combinations capable of resulting in unwanted intermodulation products are given in recommendation ITU-R SM.332.

The BER in the output shall be determined as described in 6.8.

8.4.3 Results required

The BER shall be equal to or less than 10^{-2}.

8.5 Spurious response rejection

8.5.1 Objective

To measure the ability of the receiver to receive a wanted modulated signal at the nominal frequency without exceeding a specified BER due to the presence of an unwanted signal at any other frequency band outside the passband of the receiver.

8.5.2 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.

The manufacturer shall provide the test house with a simple block diagram showing:

– IF frequencies used;
– local oscillator frequencies used;
– coverage range;
– pre-first mixer filtering arrangement.

Tests shall be made with two signal generators connected to the input of the receiver in accordance with 6.5.

The wanted signal shall be on the test frequencies as specified in 6.6. The wanted signal shall be standard test signal No. 1 at an input level of +8 dBμV e.m.f. for MF and +3 dBμV e.m.f. for HF.

The coverage range is:

– between 1 605 kHz and 4 000 kHz for MF receivers;
– between 1 605 kHz and 27 500 kHz for MF/HF receivers.

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

Tests shall be made with various frequencies of the unwanted signal to achieve the following:

– a complete search of the coverage range;
– a measurement of all IF frequencies outside the coverage range;
– a measurement of all frequencies defined by:
  - $n \times f_{lo1} \pm f_{if1}$
  - $p \times f_r \pm f_{if1}$
  - $(f_{lo2} \pm f_{if2}) \pm f_{lo1}$

where

– n and p are integers;
– f_{lo1} is the local oscillator frequency of the first mixer;
– f_{if1} is the first IF;
– f_{lo2} is the local oscillator frequency of the second mixer;
– f_{if2} is the second IF;
– 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 shall be chosen in the same band as the IF frequency without being closer than 100 kHz to 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 of the IF frequency.

The BER in the output shall be determined as described in 6.8.

8.5.3 Results required

The BER shall be equal to or less than 10^{-2}.

8.6 Dynamic range

8.6.1 Objective

To determine the range from the maximum usable sensitivity to the maximum level of an input signal at which the BER in the output of the receiver does not exceed a specified value.

8.6.2 Method of measurement

The arrangements for applying the test signals shall be in accordance with 6.5.

Standard test signal No. 1 shall be applied at an input level of +80 dBμV.

The BER in the output shall be determined as described in 6.8.

8.6.3 Results required

The BER shall be equal to or less than 10^{-2}.

8.7 Conducted spurious emissions into the antenna

8.7.1 Objective

To determine all internally generated signals conducted to the antenna terminal and which may be radiated.

8.7.2 Method of measurement

The receiver antenna terminal shall be connected to a 50 Ω artificial antenna and the spurious emissions shall be measured, using a selective measuring instrument. The r.m.s value of any component of the spurious emission shall then be evaluated.

The measurement shall be made over the frequency range from 9 kHz to 2 GHz.

The bandwidth of the selective measuring instrument shall be:

– 200 Hz in the frequency range from 9 kHz to 150 kHz;
– 9 kHz to 10 kHz in the frequency range from 150 kHz to 30 MHz;
– 100 kHz to 120 kHz in the frequency range from 30 MHz to 1 GHz; and
– 1 MHz above 1 GHz.

The detector shall be a peak detector.

8.7.3 Results required

The power of any discrete frequency component shall not exceed 2 nW.

8.8 Protection of receiver antenna input circuits

8.8.1 Objective

To determine the ability of the receiver antenna input circuits to withstand large voltages for a specified time.

8.8.2 Method of measurement

The arrangements for applying the test signals shall be in accordance with 6.5.

An unmodulated radiofrequency signal at a level of 30 V r.m.s. at a single frequency in the range 100 kHz to 27,5 MHz is applied to the receiver antenna input for a period of 15 min. The signal shall then be removed and the EUT be subjected to a performance check.

8.8.3 Results required

The receiver shall not suffer damage and shall meet the requirement of the performance check.

8.9 Stop/start

8.9.1 Objective

To verify that an independent DSC equipment can start and stop the scanning sequence, or that the scanning sequence can be controlled by direct frequency commands.

8.9.2 Method of measurement

Control signals or frequency commands in accordance with 5.5.3 shall be applied to the interface for stop/start of the scanning receiver.

8.9.3 Results required

It shall be possible to stop and start the scanning sequence.

8.10 Stop/start of scanning efficiency

8.10.1 Definition

Scanning efficiency is the ability of the receiver/decoder to correctly receive calls preceded by more than 20 bits of a 200 bit dot pattern and transmitted on one frequency whilst scanning up to six frequencies, ignoring all other signals and noise.

8.10.2 Method of measurement

Two RF test signals with a level of 20 dBμV shall be applied to the receiver. One of the RF signals shall have a nominal frequency corresponding to a frequency in the scanning sequence and be standard test signal No. 1 containing a single DSC distress call. The other RF signal shall have a nominal frequency corresponding to another frequency being scanned. It shall be standard test signal No. 1 containing DSC calls with a 20 bit dot pattern. The distress call sequences shall be repeated after a random interval of 2,5 s to 4,0 s. The receiver shall be set to scan the maximum number of frequencies for which it is designed. The number of transmitted calls shall be 200 and the symbol error rate shall be determined as described in 4.4.

8.10.3 Results required

The total number of received distress calls shall be equal to or exceed 95 % of distress calls transmitted and the BER shall be $\leq 10^{-2}$.

9 VHF watchkeeping receiver

9.1 Calling sensitivity

9.1.1 Objective

To determine the maximum usable sensitivity which is the minimum level of the signal (e.m.f.) at the nominal frequency of the receiver which, when applied to the receiver input with a standard test signal, will produce a specified BER.

9.1.2 Method of measurement

The arrangements for applying the test signals shall be in accordance with 6.5.

Standard test signal No. 2 shall be applied at an input level of 0 dBμV under normal test conditions and +6 dBμV under extreme test conditions.

The BER at the output shall be determined as described in 6.8.

The measurement shall be carried out under normal test conditions (see 6.3) and under extreme test conditions (6.4.1 and 6.4.2 applied simultaneously).

Measurements under extreme conditions may be carried out during environmental tests (see 7.4.1 and 7.4.3).

The measurement shall be repeated at the nominal carrier frequency ±1,5 kHz under normal test conditions.

9.1.3 Results required

The BER shall be equal to or less than 10^{-2}.

9.2 Adjacent channel selectivity

9.2.1 Objective

To determine the capability to receive a wanted modulated signal without exceeding a specified BER due to the presence of an unwanted modulated signal in channels adjacent to that of the wanted signal. The adjacent channel selectivity is expressed as the ratio of the levels at the receiver input of an unwanted signal to a wanted signal which results in a specified BER.

9.2.2 Method of measurement

The arrangements for applying the test signals shall be in accordance with 6.5.

The wanted signal shall be standard test signal No. 2 at an input level of +3 dBμV.

The unwanted signal shall be modulated by 400 Hz with a deviation of ±3 kHz. The unwanted signal shall be tuned to the centre frequency of the upper adjacent channels. The level of the unwanted signal shall be +73 dBμV.

The BER at the output of the receiver shall be determined as described in 6.8.

The measurement shall be repeated with the unwanted signal tuned to the centre frequency of the lower adjacent channel.

9.2.3 Results required

The BER shall be equal to or less than 10^{-2}.

9.3 Co-channel rejection

9.3.1 Objective

To determine the capability to receive a wanted modulated signal without exceeding a specified BER due to the presence of an unwanted modulated signal, both signals being at nominal frequency of the receiver.

9.3.2 Method of measurement

The arrangements for applying the test signals shall be in accordance with 6.5.

The wanted signal shall be standard test signal No. 2 at an input level of +3 dBμV.

The unwanted signal shall be modulated by 400 Hz with a deviation of ±3 kHz. The input level of the unwanted signal shall be –7 dBμV.

Both input signals shall be at the nominal frequency of the receiver and the measurement shall be repeated for displacements of the unwanted signal of up to ±3 kHz.

The BER at the output of the receiver shall be determined as described in 6.8.

9.3.3 Results required

The BER shall be equal to or less than 10^{-2}.

9.4 Intermodulation response

9.4.1 Objective

To determine the capability to limit intermodulation products originating from two or more (generally unwanted) signals at specified levels simultaneously present in a non-linear circuit.

9.4.2 Method of measurement

The arrangements for applying the test signals shall be in accordance with 6.5.

The wanted signal represented by signal generator A shall be at the nominal frequency of the receiver and shall be standard test signal No. 2 at an input level of +3 dBμV.

The two unwanted signals shall be applied, both at the same level of +68 dBμV.

The first unwanted signal from signal generator B shall be unmodulated and adjusted to a frequency 50 kHz above (or below) the nominal frequency of the receiver.

The second unwanted signal from signal generator C shall be modulated by 400 Hz with a deviation of ±3 kHz and adjusted to a frequency 100 kHz above (or below) the nominal frequency of the receiver.

The BER at the output of the receiver shall be determined as described in 6.8.

9.4.3 Results required

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

9.5 Spurious response and blocking immunity

9.5.1 Objective

To determine the ability to receive a wanted modulated signal without exceeding a specified BER due to the presence of an unwanted unmodulated signal at frequencies outside the passband of the receiver.

9.5.2 Method of measurement

The arrangements for applying the test signals shall be in accordance with 6.5.

The wanted signal shall be standard test signal No. 2 at an input level of +3 dBμV.

For the spurious response test the unwanted signal shall be unmodulated and at an input level of +73 dBμV. The frequency shall be varied over the range 9 kHz to 2 GHz except for the channel of the wanted signal and its adjacent channels.

For the blocking immunity test the unwanted signal shall be unmodulated and at an input level of +93 dBμV. The frequency shall be varied between –10 MHz and –1 MHz and also between +1 MHz and +10 MHz relative to the nominal frequency of the wanted signal.

The BER at the output of the receiver shall be determined as described in 6.8.

9.5.3 Results required

The BER shall be equal to or less than 10^{-2}.

9.6 Dynamic range

9.6.1 Objective

To determine the range from the maximum usable sensitivity to the maximum level of an input signal at which the BER in the output of the receiver does not exceed a specified value.

9.6.2 Method of measurement

The arrangements for applying the test signals shall be in accordance with 6.5.

Standard test signal No. 2 shall be applied at an input level of +100 dBμV.

The BER at the output shall be determined as described in 6.8.

9.6.3 Results required

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

9.7 Conducted spurious emissions into the antenna

9.7.1 Objective

To determine internally generated signals conducted to the antenna terminal and which may be radiated.

9.7.2 Method of measurement

The receiver antenna terminal shall be connected to a 50 Ω artificial antenna and the spurious emissions shall be measured using a selective measuring instrument. The r.m.s. value of any component of the spurious emission shall then be evaluated.

The measurement shall be made over the frequency range from 9 kHz to 2 GHz.

The bandwidth of the selective measuring instrument shall be:

– 200 kHz in the frequency range from 9 kHz to 150 kHz;
– 9 kHz to 10 kHz in the frequency range from 150 kHz to 30 MHz;
– 100 kHz to 120 kHz in the frequency range from 30 MHz to 1 GHz; and
– 1 MHz above 1 GHz.

The detector shall be a peak detector.

9.7.3 Results required

The power of any discrete frequency component shall not exceed 2 nW.

10 EMC

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

11 EMI

Tests for EMI shall be performed in accordance with IEC 60945.

The tests will be considered to be successful if they meet the requirements of the criteria A, B and C as applicable. To test for compliance with the three criteria, a performance check shall be applied during or after each test as described in IEC 60945.

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 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 number 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 carried out show that a BER of 1 % corresponds to a symbol error rate of 0,7 % to 1,0 %.

Error rates generally decrease very fast 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.

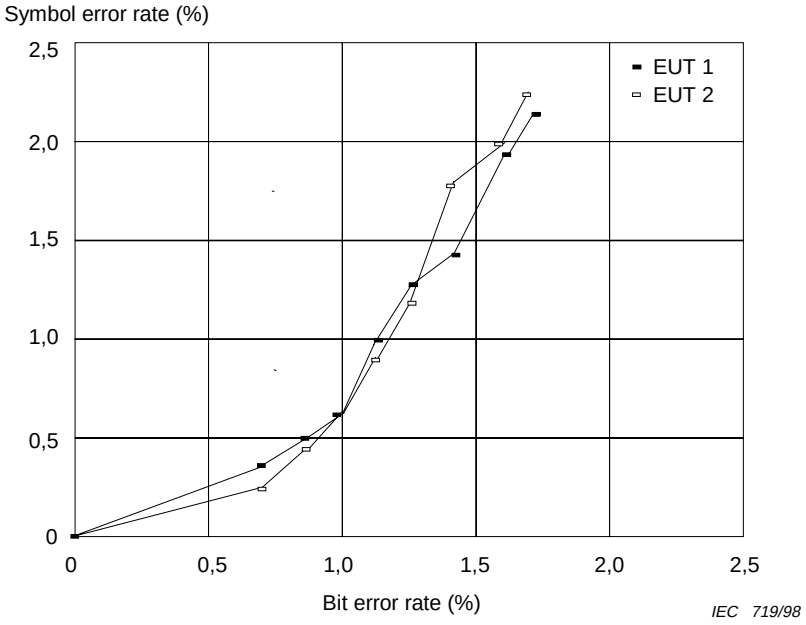

Figure A.1 – Symbol error rate (%) versus bit error rate (%) – individual call

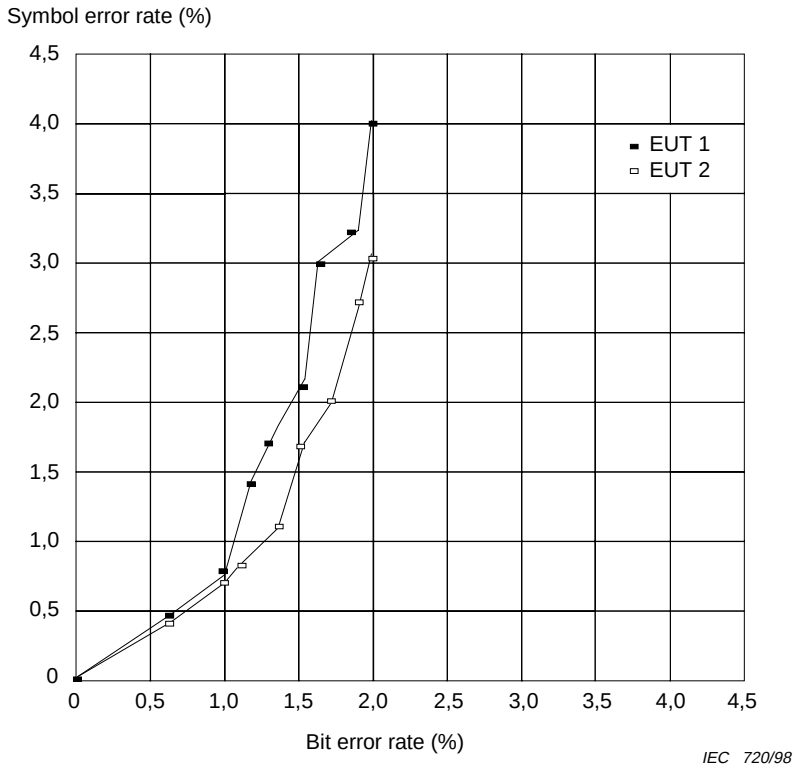

Figure A.2 – Symbol error rate (%) versus bit error rate (%) – distress call

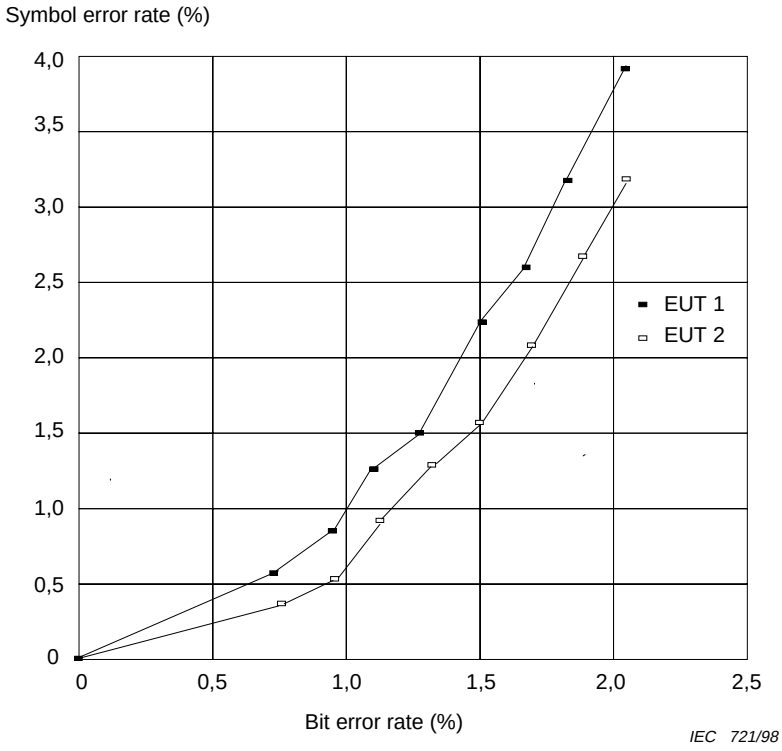

Figure A.3 – Symbol error rate (%) versus bit error rate (%) – all ship call

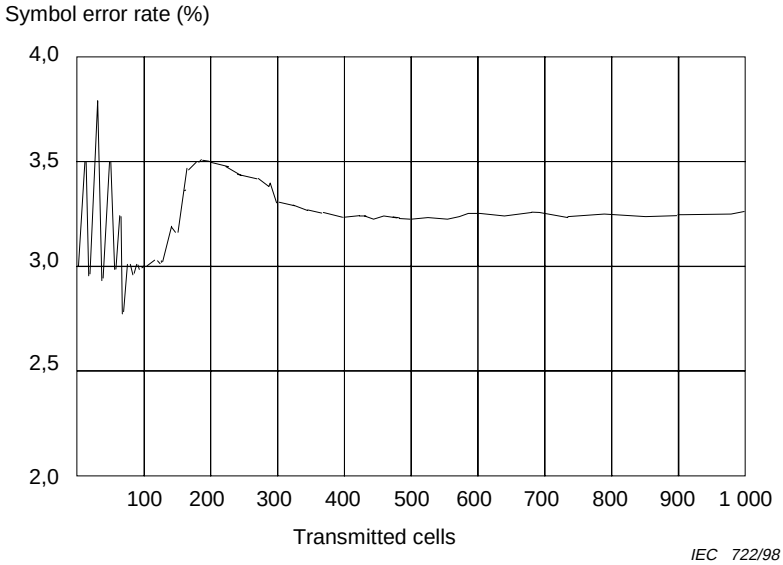

Figure A.4 – Symbol error rate (%) versus transmitted calls (distress call – EUT 1)

Annex B
(informative)

Use of FSK demodulators for testing DSC watchkeeping receivers

B.1 Introduction

The measurements specified in this standard are based on the use of a suitable FSK demodulator, connected to the output terminal of the receiver to determine the bit error rate (BER) of the output signal at the analogue audio frequency signal output of the watchkeeping receiver.

Telecom Denmark has carried out measurements in order to investigate whether the FSK demodulator will contribute to the BER measured at the output of the FSK modulator, especially in the case of the relatively low signal-to-noise ratios involved when measuring the performance of the watchkeeping receiver. For the purpose of the measurements, two FSK demodulators have been constructed, one of them based on a single chip integrated modem Texas Instruments TCM3105, the other one based on a somewhat simpler integrated circuit.

The measurements have been carried out by feeding a known FSK bit stream to the input of the FSK demodulator and comparing the output from the FSK demodulator with the input, thus determining the BER produced by the FSK demodulator. The measurements have been carried out for various S/N ratios of the input signal, and for both of the FSK demodulators.

Figure B.1 illustrates some of the results.

The investigations made show that:

– a suitable FSK demodulator can easily be constructed, for example by use of the integrated circuit TCM3105 mentioned above;
– very simple FSK demodulators may not fulfil the requirements needed for the purpose; and
– the BER produced by a FSK demodulator will, for well designed FSK demodulators, be very low for S/N ratios down to about 4 dB to 5 dB.

NOTE – IMO resolution A.806 for MF/HF DSC receivers states that a symbol error rate of 1 % should be obtained for a S/N ratio of 12 dB. Measurements carried out by Telecom Denmark prove that an SER of 1 % is equal to a BER of about 1 %. In practice, a SER or BER of 1 % is normally obtained for a S/N ratio around 8 dB to 10 dB. See also reports ITU-R M.501[12] and ITU-R PI.322 [13]. According to calculations carried out, which were based on the method given in report ITU-R PI.322, a S/N ratio of around 8 dB will be required to obtain a BER of 1 % at MF/HF.

As an extra check, the performance (sensitivity, co-channel selectivity, adjacent channel selectivity, intermodulation) of a typical VHF DSC watch receiver, which has earlier been type tested together with its separate DSC decoder, has been measured using the FSK demodulators mentioned above. Comparison of the results thus obtained shows that the use of suitable FSK demodulators – such as the demodulator based on TCM3105 mentioned above – does not contribute to the BER.

B.2 Conclusion

The measurements carried out confirm that the methods of measurement specified in this standard are feasible for DSC watchkeeping receivers with analogue audio frequency signal output by using suitable FSK demodulators.

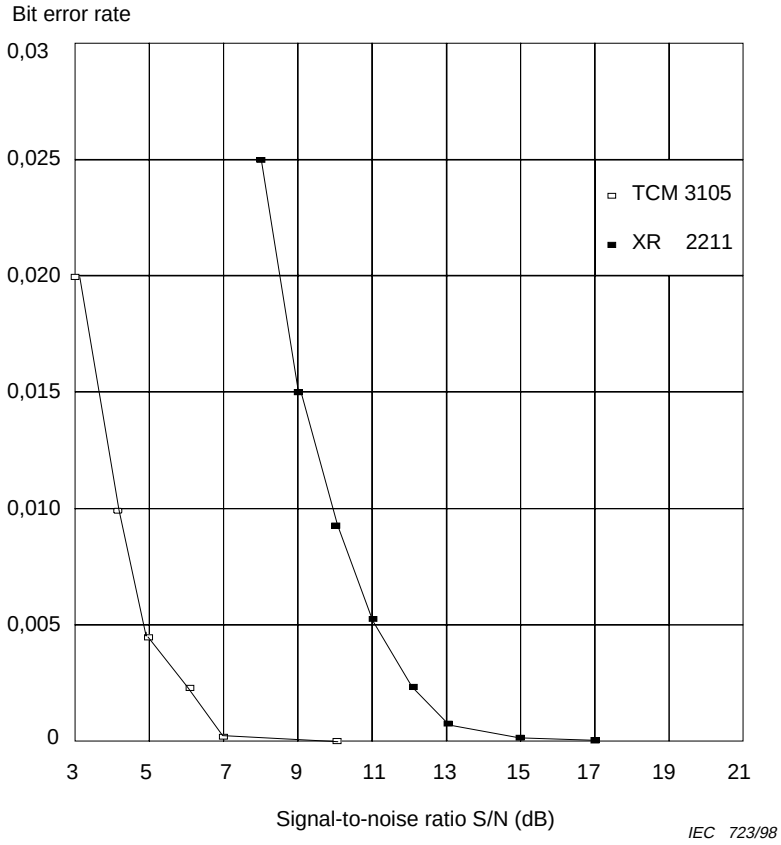

Figure B.1 – Bit error rate versus signal-to-noise ratio (dB)

Annex C
(informative)

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