INTERNATIONAL STANDARD

IEC 61993-1

First edition
1999-04

Maritime navigation and radiocommunication equipment and systems –

Part 1:
Shipborne automatic transponder system installation using VHF digital selective calling (DSC) techniques – Operational and performance requirements, methods of testing and required test results

Matériels et systèmes de navigation et de radiocommunication maritimes –

Partie 1:
Installation de systèmes de répondeur automatique de bord de navires utilisant des techniques d'appel sélectif numérique en ondes métriques – Exigences d'exploitation et de fonctionnement, méthodes d'essai et résultats d'essai exigés

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS –

Part 1: Shipborne automatic transponder system installation using VHF digital selective calling (DSC) techniques – Operational and performance requirements, methods of testing and required test results

FOREWORD

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3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical reports or guides and they are accepted by the National Committees in that sense.
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International Standard IEC 61993-1 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
80/212/FDIS	80/222/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.

Annex B is an integral part of the standard.

Annexes A and C are for information only.

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

INTRODUCTION

In 1995 the IMO instigated work on the development of performance standards for a shipborne automatic identification system (AIS) using VHF digital selective calling (DSC) techniques.

These performance standards were developed into a draft resolution which was expected to be adopted by the IMO Maritime Safety Committee. However, there were objections to this on the grounds that some requirements for AIS were not met by the draft resolution.

The outcome has been that IMO has now developed further performance standards for a “Universal AIS” as a resolution which was adopted by the IMO Maritime Safety Committee in May 1998 as MSC. 74(69) annex 3.

During this period, some countries have gone ahead and implemented operational systems based upon the original IMO draft performance standards for AIS. There is therefore a need for a technical testing standard for such equipment.

At their plenary meeting in September 1997, technical committee 80 came to the following decisions:

– a draft technical standard which had been prepared on the basis of the original IMO performance standards would go ahead with the reference 61993-1, but would not directly refer to any IMO resolution for AIS;
– work would commence at the earliest opportunity on preparing a technical standard for a “Universal AIS” based rigorously upon the IMO resolution MSC.74(69) and a new recommendation ITU-R M.1371. This standard would have the reference 61993-2.

MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS –

Part 1: Shipborne automatic transponder system installation using VHF digital selective calling (DSC) techniques – Operational and performance requirements, methods of testing and required test results

1 Scope

This part of IEC 61993 specifies the performance requirements, technical characteristics, operational requirements, methods of testing and required test results for shipborne automatic transponder system installations using VHF digital selective calling (DSC) techniques and is associated with IEC 60945. When a requirement in this standard is different from IEC 60945, the requirement in this standard shall take precedence.

The shipborne transponder installation is intended to assist in the efficient operation of ship-reporting systems and vessel traffic services (VTS) by enabling operators to identify, poll and automatically locate and track ships when they are approaching, entering and sailing within the limits of a ship-reporting system.

The system may also be used for the identification of ships by a ship and ships by aircraft. A description of the system is given in annex C.

This standard

– incorporates the technical characteristics included in ITU-R Recommendation M.825 for transponder systems using DSC and the technical characteristics included in ITU-R Recommendation M.489 for VHF radiotelephone equipment;

– incorporates the technical characteristics of DSC equipment and the operational procedures for its use contained in Recommendations ITU-R M.493 and ITU-R M.541;

– incorporates applicable parts of the performance standards of IMO Resolution A.803 for shipborne VHF radio installations;

– takes account of IMO Resolution A.694 for general requirements; and

– conforms with the International Telecommunication Union (ITU) Radio Regulations where applicable.

This standard for a transponder system is not intended to meet the requirements for a universal automatic identification system (AIS), as detailed in IMO Resolution MSC.74(69) annex 3.

NOTE – All text in this standard whose meaning complies with that in the normative references, namely IMO Resolution A.803(19) and ITU-R Recommendations M.825, M.489, M.493 and M.541 is followed by a reference to the source (number of IMO Resolution or ITU-R Recommendation and paragraph number) in brackets.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 61993. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However parties to agreements based on this part of IEC 61993 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative documents referred to applies. 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 testing results*

IEC 61097-7:1996, *Global maritime distress and safety system (GMDSS) – Part 7: Shipborne VHF radiotelephone transmitter and receiver – Operational and performance requirements, methods of testing and required test results*

IEC 61162 (all parts), *Maritime navigation and radiocommunicaation equipment and systems – Digital interfaces*

IMO International Convention for 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 (GMDSS) and for electronic navigational aids*

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

IMO MSC.74(69):1998, *annex 3 – Performance standards for an Universal shipborne automatic identification system (AIS)*

ITU Radio Regulations:1997

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-R Recommendation M.825-2:1997, *Characteristics of a transponder system using digital selective-calling techniques for use with vessel traffic services and ship-to-ship identification*

ITU-R Recommendation M.1371:1998, *Technical characteristics for a universal shipborne automatic identification system using time division multiple access in the VHF maritime mobile band*

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

ITU-T Recommendation V.24:1996, *List of definitions for interchange circuits between data terminal equipment (DTE) and data circuit-terminating equipment (DCE)*

ITU-T Recommendation V.28:1993, *Electrical characteristics for unbalanced double-current interchange circuits*

3 Definitions and abbreviations

3.1 Definitions

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

3.1.1
status
navigational status of the ship as expressed by the second digit 1-7 of the two-digit symbols to indicate other ships (table 3 of Recommendation ITU-R M.825)

3.1.2
performance check
quick test under normal test conditions of the transmitter frequency error to 13.1, the transmitter output power to 13.2 (high power only) and the receiver calling sensitivity to 14.1, with standard test signal number 2 applied at a level of +12 dBμV. For results required, see 9.1.2

3.1.3
sensor
device which provides information to the system such as position, course and speed

3.2 Abbreviations

BER	Bit error rate
DCE	Data circuit-terminating equipment
DSC	Digital selective calling
DTE	Data terminal equipment
ECDIS	Electronic chart display and information system
EMC	Electromagnetic compatibility
e.m.f.	Electromotive force
EUT	Equipment under test
GMDSS	Global maritime distress and safety system
GPS	Global positioning system
IEC	International Electrotechnical Commission
IMO	International Maritime Organization
ITU	International Telecommunication Union
ITU-R	ITU Radiocommunication sector (formerly CCIR)
ITU-T	ITU Standardization sector (formerly CCITT)
MMSI	Maritime mobile service identity
p.t.t.	press-to-transmit
r.m.s.	root-mean-square
SOLAS	Safety of Life at Sea (International convention for the)
UTC	Universal time co-ordinated
VHF	Very high frequency
VTS	Vessel traffic services

4 General requirements

4.1 General

4.1.1 Requirements contained in clause 4 cannot be verified by repeatable measurements. The manufacturer shall declare that compliance to these requirements is achieved and shall provide relevant documentation. The declaration(s), documentation and, when necessary, the equipment shall be checked.

4.1.2 The system shall have a high level of availability, shall enable operators to obtain information from the ship automatically, whenever practicable, and require a minimum of involvement of ship's personnel, thus reducing the burden of communication on board ships.

4.1.3 The system installation, in addition to meeting the requirements of the Radio Regulations, the relevant ITU-R recommendations [1)] and the general requirements set out in IMO A.694, as detailed in IEC 60945, shall comply with the following requirements and the requirements contained in clauses 5 and 6 of this standard.

4.2 Composition

4.2.1 The installation shall comprise of at least

– a transmitter/receiver including antenna;
– a digital selective calling facility;
– a dedicated DSC watchkeeping facility to maintain watch on the designated calling frequency except during periods when the installation is required to operate on working channels in accordance with instructions from shore-based stations;
– an electronic position-fixing system capable of providing horizontal accuracy of 100 m (95 %);
– means to input and receive information;
– means for the automatic change to a working channel on request of the shore-based interrogating station.

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

4.3 Design and construction

4.3.1 The installation shall operate continuously while underway or at anchor. The equipment shall be designed for continuous operation.

4.3.2 The system functions may be performed by separate units appropriately interconnected or be integrated with a radio transmitter and/or receiver.

NOTE – "Integrated" means that the system function is physically integrated into a radio transmitter and/or receiver so that the system functions can only be tested by RF measurements.

4.4 Controls and indicators

4.4.1 The installation shall be provided with visual indication to show

– the equipment is switched on;
– the transponder function is disabled;
– the equipment is being interrogated; and
– the equipment is transmitting;
– loss of external data.

———————

1) Recommendations ITU-R M.825, M.493, M.541

4.5 Interfacing

4.5.1 To enable a user display of information for example at a radar or ECDIS, the system shall be provided with a serial interface conforming to IEC 61162.

4.5.2 Interfaces for external sensors providing data for the system shall conform to IEC 61162.

4.5.3 As a minimum, the system shall be capable of operating with the sentences GGA, GLL, VBW, VTG, DSI, and DSR of IEC 61162.

4.5.4 When the installation comprises an external watch receiver, input terminals for AF, or alternatively DSC signals at logic level, the interfaces shall be as follows.

4.5.4.1 AF terminals for DSC signals shall have input and output impedance of 600 Ω, symmetrical and free of earth, with a closed-circuit level adjustable to 0,775 V (r.m.s.) ± 10 dB for connection to AF terminals of external radio equipment.

4.5.4.2 Alternatively, terminals for DSC signals at logic levels shall have the electrical characteristics compatible with Recommendation ITU-T V.11. The B-state shall be the logic "0", and the Y-state shall be the logic "1".

4.5.4.3 Additionally, terminals for DSC signals may be provided with characteristics as defined in ITU-T Recommendations V.24 and V.28.

4.6 Permissible warming-up period

The installation shall be operational within 1 min of switching on.

NOTE – Sensors used with the system shall meet the requirements of their individual product standards (for example, IEC 61108-1 for GPS which permits 30 min to operation when there is no valid almanac data available).

5 Performance requirements

5.1 General

5.1.1 The system shall provide for calls of the category safety using DSC. (825/6.1)

5.1.2 Means shall be provided to automatically record all periods when the installation is non-functioning. It shall not be possible for the user to alter any information recorded by this device.

5.1.3 The last 10 times when the equipment is non-functioning for more than 15 min shall be recorded in UTC time and duration in a non-volatile memory. Means shall be provided to recover this data.

5.1.4 The installation shall be capable of receiving and processing all calls transmitted by an interrogating station.

5.1.5 The installation may not be required to process DSC type calls which are not AIS calls; however, such calls shall not affect correct system operation.

5.1.6 The installation shall be capable of operating on single-frequency channels or on single- or two-frequency channels.

5.1.7 The installation shall be capable of automatically transmitting a response. An automatic response shall be transmitted to any interrogation containing one or more of the symbols 101, 102, 103, 108, 109, 111, 112 and 116.

5.1.8 When an automatic response is required but the requested information is not available, the relevant symbol shall be followed by the symbol 126. Symbol 126 shall also be transmitted for null-fields in the DSI sentence of IEC 61162.

5.2 Compatibility

5.2.1 Where the installation is combined with other VHF installations, in accordance with ITU Radio Regulations Article 61, interrogating transmissions shall have priority over all communications other than those of a higher priority as prescribed in that article. Facilities shall be provided to disable the installation for communications of higher priority.

5.2.2 Such facilities shall be adequately protected from inadvertent operation and the times of disabling recorded in conformity with 5.1.2. Continuous watch on the designated calling frequency (Channel 70) shall be maintained irrespective of the frequency being used for communications by the installation.

5.2.3 In a combined installation, the system is permitted to operate the transmitter for the duration of a DSC call for system purposes provided that after the transmission the VHF installation returns automatically to its previous settings. Interrogations containing symbol number 101 to table 4 of Recommendation ITU-R M.825 shall cause the system to respond on the VHF channel indicated for any following symbols in the interrogating message. The system shall then return to channel 70 operation. If symbol number 101 is followed by symbol number 102, all subsequent position reports shall be made on the indicated VHF channel. These position reports will not normally be acknowledged by the originator of the request.

5.3 Identification

For the purpose of ship identification, the appropriate MMSI shall be used.

6 Operational requirements

6.1 Ship-shore identification

6.1.1 To enable shore-based authorities to identify the ship, the following information, which it shall not be possible for the user to change, shall be programmed in a secure manner into the installation:

– ship’s MMSI;

– ship’s name (symbol number 115 to table 4 of ITU-R M.825);

– ship’s length (symbol number 124 to table 4 of ITU-R M.825); and

– type of ship (symbols numbers 50-55, 58, 59, 69, 79, 89 and 99 to table 3 of ITU-R M.825).

6.1.2 The following information shall be programmed into the installation automatically, either from integral equipment or from suitable sensor sources:

– ship’s position (symbol number 100 to table 4 of ITU-R M.825);

– course of ship over ground (symbol number 119 to table 4 of ITU-R M.825); and

– speed of ship over ground (symbol number 120 to table 4 of Recommendation ITU-R M.825).

NOTE – Where external sensors are used, these shall be protected against de-activation by the user.

6.1.3 Facilities shall be provided to enable the user to readily programme additional information into the installation in accordance with the relevant ITU-R Recommendation [2)].

6.1.4 The additional information shall include at least

– draught (symbol number 123 to table 4 of ITU-R M.825);
– next port of call (symbol number 121 to table 4 of ITU-R M.825);
– destination (symbol number 114 to table 4 of ITU-R M.825);
– entering or leaving VTS (symbols numbers 105 and 107 to table 4 of ITU-R M.825); and
– status (applicable second digit 1-7 of symbols to indicate other ships to table 3 of ITU-R M.825).

6.1.5 Where facilities to programme additional information are not integral to the system they shall be provided to the installation via a serial interface complying to IEC 61162.

6.2 Ship-ship identification

6.2.1 For ship-to-ship identification purposes, the installation shall not allow the user to transmit interrogation messages addressed to a group of ships other than to a numerical geographic address no larger than 0,5 square nautical miles in area.

6.2.2 To enhance identification, the installation shall provide facilities to use other forms of address so as to add either course or ship type to the geographic address, in accordance with ITU-R M.825, in any interrogation message.

6.2.3 The installation shall permit the user to obtain, in addition to the ship's MMSI, the following information from addressed ships for identification purposes:

– position (symbol number 100 to table 4 of ITU-R M.825);
– course over ground (symbol number 119 to table 4 of ITU-R M.825);
– speed (symbol number 120 to table 4 of ITU-R M.825); and
– ship's name and call sign (symbol number 115 to table 4 of ITU-R M.825). (8.3)

6.2.4 It shall not be possible for the user to obtain additional information from other ships by use of the installation.

6.2.5 Means shall be provided to prevent more than three call attempts from the system in any period of 15 min.

6.2.6 Ship-to-ship interrogation shall be at low transmitting power, in the range of between 0,1 W and 1 W.

7 Technical requirements

7.1 Channel sensing

7.1.1 Provision shall be made for sensing the VHF channel 70 used for digital selective calling purposes to determine the presence of a signal, for automatically preventing the transmission of a transponder call until the channel is free.

2) Recommendation ITU-R M.825

7.2 Class of emission and modulation characteristics

7.2.1 Class of emission shall comply with appendix 19 of the Radio Regulations. (803/3.4)

7.2.2 The class of emission shall be phase modulation G2B for DSC signalling. (489/1.1.1 and 1.1.3)

7.3 Frequency bands and channels

7.3.1 The equipment shall be capable of operating as follows:

– in the band 156,3 MHz to 156,875 MHz on single-frequency channels as specified in appendix S18 to the Radio Regulations including at least 156,525 MHz (channel 70); and

– in the band 156,025 MHz to 157,425 MHz for transmitting and the band 160,625 MHz to 162,025 MHz for receiving on two-frequency channels as specified in appendix S18 to the Radio Regulations. (803/3.2)

7.3.2 Where duplex or semi-duplex systems are in use, the performance of the equipment shall continue to comply with the requirements of this standard. (489/1.1.4)

7.3.3 The equipment shall be designed to operate satisfactorily with a channel separation of 25 kHz in accordance with appendix S18 of the Radio Regulations.

7.4 Switching time

7.4.1 Change of frequency shall be capable of being made as rapidly as possible, but in any event within 5 s. (803/4.1.1)

7.4.2 The time taken to switch from the transmit to the receive conditions, and vice versa, shall not exceed 0,3 s. (803/4.1.2)

7.5 Safety precautions

7.5.1 The installation, when operating, shall not be damaged by the effects of open-circuited or short-circuited antenna terminals.

7.5.2 The equipment shall not be able to transmit during channel switching operation. (803/4.1.7)

7.5.3 Operation of the transmit/receive (p.t.t.) control shall not cause unwanted emissions. (803/4.1.8)

7.6 Transmitter

7.6.1 The frequency tolerance for ship station transmitters shall not exceed 10 parts in 10^6. (489/1.2.1) For practical reasons, the frequency error shall be within ±1,5 kHz.

7.6.2 The transmitter output power shall be between 6 W and 25 W.

7.6.3 Provision shall be made for reducing the transmitter output power to a value of between 0,1 W and 1 W. However, this reduction of the power is optional on channel 70. (803/7.2)

7.6.4 The frequency deviation shall not exceed ±5 kHz. Deviation limiting circuits shall be so employed that the maximum frequency deviation attainable shall be independent of the input audio frequency. The frequency deviation corresponding to 100 % modulation shall approach ±5 kHz as nearly as practicable. (489/1.2.5)

7.6.5 Spurious emissions on discrete frequencies, when measured in an artificial antenna as described in 8.7.5, shall be in accordance with the provisions of appendix S3 of the Radio Regulations. (489/1.2.2)

The power of any conducted spurious emission on any discrete frequency shall not exceed 0,25 μW in the frequency range 9 kHz to 1 GHz and 1 μW in the frequency range 1 GHz to 2 GHz.

7.7 Receiver

7.7.1 With a DSC modulated input signal having a level of 1 μV e.m.f. to its associated VHF receiver, the DSC transponder installation shall be capable of decoding the received message with a maximum permissible output character error rate of 10^{-2}. (See annex A for the rationale for using BER measurements.)

7.7.2 The immunity to interference of the receiver shall be such that the wanted signal is not seriously affected by unwanted signals.

7.7.3 The co-channel rejection ratio shall be between –8 dB and 0 dB.

7.7.4 The adjacent channel selectivity shall be at least 70 dB. (489/1.3.2)

7.7.5 The blocking immunity shall be 90 dB.

7.7.6 The intermodulation response ratio shall be 65 dB. (489/1.3.4)

7.7.7 The power of any conducted spurious emission, measured at the antenna terminals, shall not exceed 2,0 nW at any discrete frequency in the frequency range 9 kHz to 2 GHz. (489/1.3.5)

7.8 Antenna system

The VHF antenna or antennas shall be vertically polarized and, as far as practicable, be omni-directional in the horizontal plane. The installation shall be suitable for efficient radiation and reception of signals at the operating frequencies.

7.9 Power supply

7.9.1 The installation shall be powered from the ship's main source of electrical energy. In addition, it shall be possible to operate the installation from an alternative source of electrical energy.

7.9.2 All sensors necessary for the satisfactory operation of the installation shall be capable of operating from an alternative source of supply, preferably that used for the installation itself.

7.10 System DSC facility

The system DSC facility shall conform to the provisions of the relevant ITU-R recommendations pertaining to the DSC system [3]. (803/11.1)

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[3] Recommendations ITU-R M.493, M.541, M.825

8 Test conditions

8.1 General

8.1.1 An EUT which has been tested and certified to comply with IEC 61097-3[4)] for DSC equipment and IEC 61097-7[4)] for VHF equipment needs to be tested only to 10 and 11 of this standard.

8.1.2 Testing shall be carried out under normal test conditions and also, where stated, under extreme test conditions as specified in IEC 60945, of dry heat and the upper limit of supply voltage applied simultaneously and low temperature and the lower limit of supply voltage applied simultaneously. Electrical power shall be applied to the equipment only during electrical tests and performance checks.

8.1.3 Before tests to verify whether the EUT meets all requirements of this standard, the EUT shall be subjected to a duration test of transmitting standard test call No. 1 (see 8.7.1) at 15 s intervals for the duration of 2 h.

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

8.1.5 When the system DSC function is integrated with a radiotelephone the EUT shall be provided with an accessible test point at the receiver analogue or digital signal output.

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

8.2 Unspecified tests

Requirements contained in clause 4 of this standard for which no test is specified shall be checked by examination of the equipment, the manufacturing drawings or other relevant documents. The result of the examination shall be stated in the test report.

8.3 Test power source

During each test the EUT shall be supplied from a test power source, capable of producing normal and extreme test voltages as specified in 8.4.2 and 8.5.2. For the purposes of tests, the voltage of the power supply shall be measured at the input terminals of the equipment. If the equipment is provided with a power cable permanently connected, the test voltage shall be that measured at the point of connection of the power cable to the equipment. During tests, the test power source voltages shall be maintained within a tolerance of ± 3 % relative to the voltage at the beginning of each test.

8.4 Normal test conditions

8.4.1 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 %.

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4) Or equivalent international or regional standards

8.4.2 Normal test power source

8.4.2.1 Mains voltage and frequency

The normal test voltage for equipment to be connected to the a.c. mains shall be the nominal mains voltage. For the purpose of this standard, the nominal voltage shall be the declared voltage or any one of the declared voltages for which the equipment was designed.

The frequency of the test power supply corresponding to the a.c. mains supply shall be at nominal frequency ±1 Hz.

8.4.2.2 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 (for example 12 V, 24 V).

8.4.2.3 Other power sources

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

8.5 Extreme test conditions

8.5.1 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.

8.5.2 Extreme test power source

8.5.2.1 Mains voltage and mains frequency

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

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

8.5.2.2 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 (for example 12 V, 24 V).

8.5.2.3 Other power sources

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

8.6 Procedures for tests at extreme temperatures

8.6.1 For tests at high temperature, the EUT shall be placed in a test chamber and left until thermal equilibrium is reached. The EUT shall then be switched on for 5 min in the high-power transmit condition, after which the EUT shall meet the requirements of this standard.

8.6.2 For tests at low temperature, the EUT shall be placed in a test chamber and left until thermal equilibrium is reached. The EUT shall then be switched to stand-by or receive condition for 1 min, after which the EUT shall meet the requirements of this standard.

8.7 Test signals

8.7.1 Standard test signal number 1

A system call or DSI sentence as applicable, with an individual station address and with command sets 103 (report your position) and 111 (report ship name) unless otherwise stated.

8.7.2 Standard test signal number 2

A signal with a nominal radiofrequency assigned for VHF channel 70, modulated with a 1 700 Hz subcarrier capable of being modulated with a frequency shift of ±400 Hz by a square-wave signal having a frequency of 600 Hz, simulating continuous dot pattern with frequency deviation of ±3 kHz.

8.7.3 Arrangements for test signals applied to the receiver input

Source of test signals for application to the receiver input shall be connected in such a way that the impedance presented to the receiver input is 50 Ω, irrespective of whether one or more signals are applied to the receiver simultaneously. The level of the test signals shall be expressed in terms of the emf at the terminals to be connected to the receiver. The nominal frequency of the receiver is the carrier frequency of the selected channel.

8.7.4 Arrangements for test signals applied to the transmitter input

For the purpose of this standard, the transmitter audiofrequency modulation signal shall be supplied by a generator to an interface provided by the manufacturer.

Alternatively the equipment shall have facilities, not accessible to the operator, to generate a continuous B signal, a continuous Y signal, and a continuous dot pattern.

8.7.5 Artificial antenna

When tests are carried out with an artificial antenna, this shall be a non-reactive, non-radiating 50 Ω load.

8.7.6 Choice of testing frequencies

The testing frequency shall be 156,525 MHz (channel 70).

8.8 Measurement of bit error rate (BER)

For tests on receivers with digital outputs, all measurements shall be performed by measuring the bit error rate at the digital output (see annex A).

For tests on receivers with analogue outputs, the measurements shall be performed by using a linear FSK discriminator connected to the analogue output. All receiver measurements shall then be made by measuring the bit error rate at the discriminator output.

8.9 Measurement uncertainty and interpretation of the measurement results

8.9.1 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

8.9.2 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 shall 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; and

– for each measurement, the recorded value of the measurement uncertainty shall be equal to or lower than the values in 8.9.1.

9 Environmental tests

9.1 Introduction

9.1.1 Environmental tests are intended to assess the suitability of the EUT for its intended physical conditions of use. The equipment shall be capable of continuous operation under the conditions of various sea states, vibration, humidity and change of temperature likely to be experienced in a ship in which it is installed.

9.1.2 After environmental tests, and also where specified during the test, the EUT shall comply with the requirements of a performance check as defined in clause 3.

For the transmitter the frequency error shall be less than ±1,5 kHz, and the output power shall not be less than 6 W.

For the receiver, the bit error rate shall be less than 10^{-2}.

9.1.3 Environmental tests shall be carried out in the following order.

9.2 Temperature tests

9.2.1 Dry heat

The dry heat test shall be performed as specified in IEC 60945.

Transmitter tests of frequency error and carrier power to 13.1 and 13.2, and the receiver test of calling sensitivity to 14.1 shall be conducted during this test.

9.2.2 Damp heat

The damp heat test shall be performed as specified in IEC 60945.

9.2.3 Low temperature

The low temperature test shall be performed as specified in IEC 60945.

Transmitter tests of frequency error and carrier power to 13.1 and 13.2, and the receiver test of calling sensitivity to 14.1 shall be conducted during this test.

9.3 Vibration

The vibration test shall be performed as specified in IEC 60945.

9.4 Corrosion

The manufacturer shall produce evidence that the components, materials and finishes employed in the equipment satisfy the corrosion test.

9.5 Rain

For units of the EUT intended for installation exposed to the weather, a rain test shall be performed as specified in IEC 60945.

10 Performance tests

10.1 General

10.1.1 Verify during the following tests that all calls generated by the system follow the format specified in ITU-R M.825 and are of the safety category defined in ITU-R M.493. (5.1.1)

10.1.2 Check the recording capability by rendering the EUT non-functioning for a duration of 15 min for 10 times. Check that it is possible to recover the data as per manufacturers' instructions. Check that no operational means are available for the user to alter the recorded data. (5.1.2 and 5.1.3)

10.1.3 Check that the EUT is capable of receiving, processing and automatically transmitting a response to the following calls from ITU-R M.825: 101 (command to duplex-channel), 102, 103, 108, 109, 111, 112 and 116. The sequence of calls consisting of test signals number 1 and valid geographic calls shall demonstrate the capability of the EUT to operate on single-frequency channels as well as on two-frequency channels. (5.1.4, 5.1.6 and 5.1.7)

10.1.4 Check with sequence of valid calls consisting of a test signal number 1, a geographic call from ITU-R M.493, a test signal number 1, an individual call from ITU-R M.493 and a test signal number 1 that the EUT correctly receives and processes the three test calls and its correct system operation is not affected by the interleaved calls. (5.1.5)

10.1.5 Check that the EUT does not respond to invalid calls – incorrect MMSI, position outside addressed geographic area, different course, or ship’s type.

10.1.6 Send to the EUT a DSI sentence containing null-fields and check that the transmitted call has the symbol number 126 following the relevant symbols. (5.1.8)

10.2 Compatibility

10.2.1 Send to the EUT a standard test signal number 1 with symbol 102 requesting intervals of 1 min. Check that activating the distress button of the GMDSS VHF radiotelephone initiates a distress call without delay. (5.2.1)

10.2.2 Check by examination of the EUT that facilities to disable the transponder function are adequately protected from inadvertent operation, require deliberate actions by the user, for example, two levels of menu, and the times of disabling are recorded. (5.2.2)

10.2.3 Set the GMDSS VHF radiotelephone to be operating on channel 13. Send a system call on channel 70 with an individual station address and with command sets 101 (switch channels) and 102 (report position at intervals of 1 min) to the EUT. Confirm that the position report is sent on the commanded working channel and that the EUT subsequently returns to channel 13. Send a standard test signal number 1 on channel 70 and confirm that the EUT responds on channel 70. Check that the following routine position report is transmitted on the previously commanded working channel and that the EUT subsequently returns to channel 13.

10.3 Identification (5.3)

This requirement is covered by the test to 11.1.1.

11 Operational tests

11.1 Ship-shore identification

11.1.1 Check by decoding a standard test signal number 1 with additional symbol number 108 that the ship’s maritime mobile service identity (MMSI), the ship’s name, the ship's length and the type of ship is programmed into the EUT. Repeat this test after a power supply interruption of at least 12 h to ensure that permanently stored data has not changed. Check that it is not possible for the user to change this information. (5.3 and 6.1.1)

11.1.2 Send a standard test signal number 1 with additional symbols numbers 109 and 116 and check that the reply messages 100, 119 and 120 are programmed automatically. (6.1.2)

11.1.3 Send a standard test signal number 1 with additional symbols numbers 106, 113 and 118 and check that the messages 114, 121, 123 and second digit 1-7 of symbols to indicate other ships to table 3 of ITU-R M.825 can be entered.

11.1.4 Operate the EUT and check that the messages 105, 107 can be entered.

11.1.5 Check that data inputs from external facilities for generating messages to meet the requirements of 11.1.3 and 11.1.4, when provided, comply with IEC 61162. (6.1.3, 6.1.4 and 6.1.5)

11.2 Ship-ship identification

11.2.1 Check that it is not possible to transmit a geographic call with an area of more than 1 square nautical mile [5]. (6.2.1)

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5) The increase to 1 square nautical mile takes account of inaccuracies.

11.2.2 Check with test signal number 1, addressed to a geographic area and a course identical to the steering course stored, that the EUT correctly responds. Repeat the test call with a matching ship's type inserted in the geographic call and check that the EUT correctly responds. Check that it is possible to transmit geographic calls with course or ship's type as additional qualifier. (6.2.2 and 6.2.3)

11.2.3 Check that the EUT does not transmit calls other than 103, 109, 111 and 116. (6.2.4 and 6.2.5)

11.2.4 Check by sending a sequence of four geographic addressed calls and verify that the fourth call is not transmitted. (6.2.6)

11.2.5 Transmit a standard test signal number 1 and verify that the EUT switches to low power automatically. (6.2.7)

12 Technical tests

12.1 Sensing capability (7)

12.1.1 Objective

To measure the sensing capability of the EUT. Sensing capability is the capability to detect the presence of a call on the air.

12.1.2 Method of measurement

Apply a DSC distress call to the receiver input. The input signal level shall be 0 dBμV e.m.f. under normal test conditions. Initiate a system DSC call.

12.1.3 Result required

Verify that the system DSC call is not transmitted until the DSC call is terminated.

12.2 Switching time (7.4)

12.2.1 Objective

To measure the switching time of the EUT. Switching time to change frequency is the time taken from the receive and/or transmit condition at one frequency to another. This includes manual channel selection time, the time to press p.t.t. switch, and receiver/transmitter response time.

The time taken to change from transmit to receive conditions, and vice versa on the same channel, is the total time of the time taken to switch the internal circuit plus receiver/transmitter response time.

12.2.2 Method of measurement

Transmitter output shall be connected to an artificial antenna through a coupling device, and a storage oscilloscope shall be connected to the coupling device to monitor the output level of the transmitter. Initially, the EUT shall be set at transmit condition on channel A, depressing the p.t.t. switch. Then, the EUT shall be set to transmit condition on channel B, after releasing the p.t.t. switch, changing the channel from A to B, and depressing the p.t.t. switch again. The period from the ending of transmission on channel A to the beginning of transmission on channel B shall be measured by the storage oscilloscope.

To measure the time from receive condition to transmit condition, the storage oscilloscope shall be triggered by the p.t.t. switch signal at the starting point of transmission. The period from the starting point to the point where the level of the transmitted signal reaches 90 % of the final level shall be measured.

In addition to the above measuring condition, to measure the time from transmit to receive conditions, input of the storage oscilloscope shall be connected to the receiver output with the squelch facility switched off. The p.t.t. switch signal shall be used to trigger the storage oscilloscope at the ending point of transmission. The period from the ending point to the point where the level of received noise level reaches 90 % of the final average level shall be measured.

12.2.3 Results required

Switching time of frequency change shall be within 5 s, and time of receive to transmit conditions, and vice versa, shall not exceed 0,3 s.

13 Transmitter tests

13.1 Frequency error (7.6.1)

13.1.1 Objective

To measure the frequency error, which is the difference between the measured carrier frequency and the assigned frequency.

13.1.2 Method of measurement

The carrier frequency shall be measured in the absence of modulation with the transmitter connected to an artificial antenna. The measurement shall be carried out under normal test conditions 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.

13.1.3 Results required

The frequency error shall be within ± 1,5 kHz.

13.2 Carrier power (7.6.2 and 7.6.3)

13.2.1 Objective

To measure the carrier power, which is the average power supplied to the artificial antenna during one radiofrequency cycle in the absence of modulation.

13.2.2 Method of measurement

The transmitter shall be connected to an artificial antenna and the power delivered to this artificial antenna shall be measured. The measurements shall be carried out under normal test conditions 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.

13.2.3 Results required

Normal test conditions:

With the output power switch set at maximum, the carrier power shall remain between 6 W and 25 W. The measured power is considered to be the rated output power. The carrier power with the output power switch set at minimum shall remain between 0,1 W and 1 W.

Extreme test conditions:

With the output power switch set at maximum, the carrier power shall remain between 6 W and 25 W and be within +2 dB and –3 dB of the carrier power measured under the normal test condition. With the output power switch set at minimum, the carrier power shall remain between 0,1 W and 1 W.

13.3 Frequency deviation (7.6.4)

13.3.1 Objective

To measure the frequency deviation, which for the purposes of this standard is the difference between the carrier frequency and the instantaneous frequency of the modulated radio-frequency signal.

13.3.2 Method of measurement

The frequency deviation shall be measured at the output, with the transmitter connected to an artificial antenna, by means of a deviation meter capable of measuring the maximum deviation, including that due to any harmonics and inter-modulation products which may be generated in the transmitter.

13.3.2.1 For an integrated equipment, i.e. one without an external analogue input, the equipment shall be set to generate a continuous dot pattern and the maximum frequency deviation shall be measured. This measurement shall be carried out with the output power switch set at maximum and repeated with the output power switch set at minimum.

13.3.2.2 For equipment with an external analogue input, the modulation frequency shall be varied between 100 Hz and 3 kHz. The level of this test signal shall be 20 dB above that level which produces ±3 kHz frequency deviation under normal test conditions with a modulating frequency of 1 kHz. This test shall be carried out with the output power switch set at maximum and repeated with the output power switch set at minimum.

13.3.3 Results required

The maximum permissible frequency deviation shall be ±5 kHz.

13.4 Sensitivity of the modulator (for external analogue inputs only)

13.4.1 Objective

To measure the sensitivity of the modulator. This parameter characterizes the capability of the transmitter to produce a sufficient modulation when an audiofrequency signal corresponding to a DSC signal is applied.

13.4.2 Method of measurement

An audio signal with a frequency of 1 kHz and a level of 0,775 V (r.m.s.) shall be applied to the transmitter. The resulting deviation shall be measured.

13.4.3 Results required

The resulting frequency deviation shall be between ± 1,5 kHz and ± 3 kHz.

13.5 Modulation index

13.5.1 Objective

To measure the modulation index, which for the purposes of this standard is the ratio between the frequency deviation and the frequency of the modulating signal.

13.5.2 Method of measurement

The equipment shall be set to transmit continuous B signals and then continuous Y signals. The frequency deviation shall be measured in each case.

13.5.3 Results required

The modulation index shall be 2,0 ± 10 %.

13.6 Adjacent channel power (7.3.4)

13.6.1 Objective

To measure the adjacent channel power. The adjacent channel power is that part of the total power output of a transmitter which, under defined conditions of modulation, falls within a specified passband centred on the nominal frequency of either of the adjacent channels. This power is the sum of the mean power produced by the modulation, hum and noise of the transmitter.

13.6.2 Method of measurement

The adjacent channel power shall be measured with a power measuring receiver, referred to as the "receiver", which consists of a mixer, an IF filter, an oscillator, an amplifier, a variable attenuator and an r.m.s. value indicator. Instead of the variable attenuator with the r.m.s. value indicator it is possible to use an r.m.s. voltmeter calibrated in dB. The technical characteristics of the power measuring receiver are given in annex B.

a) The transmitter shall be operated at the maximum carrier power determined in 13.2 under normal test conditions. The output of the transmitter shall be linked to the input of the "receiver" by a connecting device such that the impedance presented to the transmitter is 50 Ω and the level at the "receiver" input is appropriate;

b) with the transmitter unmodulated [6], the tuning of the "receiver" shall be adjusted so that a maximum response is obtained. This is the 0 dB response point. The "receiver" attenuator setting and the reading of the meter shall be recorded;

c) the tuning of the "receiver" shall be adjusted away from the carrier so that the "receiver" –6 dB response nearest to the transmitter carrier frequency is located at a displacement from the nominal carrier frequency of 17 kHz;

d) for equipment with an external analogue input, the transmitter shall be modulated with 1,25 kHz at a level which is 20 dB higher than that required to produce ±3 kHz deviation;

e) for fully integrated equipment the transmitter shall be modulated with a continuous dot pattern;

f) the "receiver" variable attenuator shall be adjusted to obtain the same meter reading as in b) or a known relation to it;

g) the ratio of adjacent channel power to carrier power is the difference between the attenuator settings in b) and f), corrected for any differences in the reading of the meter;

h) the measurement shall be repeated with the "receiver" tuned to the other side of the carrier.

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6) The measurement may be made with the transmitter modulated with normal test modulation, in which case this fact shall be recorded with the test results.

13.6.3 Results required

The adjacent channel power shall not exceed a value of 70 dB below the carrier power of the transmitter or 0,2 μW, whichever is higher.

13.7 Conducted spurious emissions conveyed to the antenna (7.6.5)

13.7.1 Objective

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

13.7.2 Method of measurement

Conducted spurious emissions shall be measured with the transmitter, modulated by a continuous dot pattern, connected to the artificial antenna as specified in 8.7.5. The measurement shall be made over a frequency range from 9 kHz to 2 GHz, excluding the channel on which the transmitter is operating and its adjacent channels.

13.7.3 Results required

The power of any spurious emission on any discrete frequency shall not exceed 0,25 μW in the frequency range 9 kHz to 1 GHz and 1 μW in the frequency range 1 GHz to 2 GHz.

13.8 Transient frequency behaviour of the transmitter

13.8.1 Objective

To measure the transient frequency behaviour of the transmitter. This is defined as the variation over time of the transmitter frequency difference from the nominal transmitter frequency when the radio frequency output power is switched on and off (see figure 2).

t_{on}: according to the method of measurement described in 13.8.2 the switch-on instant t_{on} of a transmitter is defined by the condition when the output power, measured at the antenna terminal, exceeds 0,1 % of the nominal power;

t_1: period of time starting at t_{on} and with duration according to table 1;

t_2: period of time starting at the end of t_1 and with duration according to table 1;

t_{off}: switch-off instant defined by the condition when the power falls below 0,1 % of the nominal power;

t_3: period of time starting according to table 1 and finishing at t_{off}.

Table 1

t_1(ms)	5,0
t_2(ms)	20,0
t_3(ms)	5,0
NOTE 1 – During the periods t_1 and t_3 the frequency difference shall not exceed the value of one channel separation NOTE 2 – During the period t_2 the frequency difference shall not exceed the value of half-a-channel separation	

13.8.2 Method of measurement

Two signals shall be connected to the test discriminator via a combining network. The transmitter shall be connected to a 50 Ω power attenuator. The output of the power attenuator shall be connected to the test discriminator via one input of the combining network (see figure 1).

A test signal generator shall be connected to the second input of the combining network. The test signal shall be adjusted to the nominal frequency of the transmitter. The test signal shall be modulated by a frequency of 1 kHz with a deviation of ±25 kHz.

The test signal level shall be adjusted to correspond to 0,1 % of the power of the transmitter under test measured at the input of the test discriminator. This level shall be maintained throughout the measurement.

The amplitude difference (ad) in figure 2 and the frequency difference (fd) in figure 2 output of the test discriminator shall be connected to a storage oscilloscope. The storage oscilloscope shall be set to display the channel corresponding to the (fd) input up to ±1 channel frequency difference, corresponding to the relevant channel separation, from the nominal frequency.

The storage oscilloscope shall be set to a sweep rate of 10 ms/division and set so that the triggering occurs at one division from the left edge of the display. The display will show the 1 kHz test signal continuously. The storage oscilloscope shall then be set to trigger on the channel corresponding to the amplitude difference (ad) input at a low level, rising.

The transmitter shall then be switched on, without modulation, to produce the trigger pulse and a picture on the display. The result of the change in the ratio of power between the test signal and the transmitter output will, due to the capture ratio of the test discriminator, produce two separate sides on the picture, one showing the 1 kHz test signal, the other the frequency of the transmitter versus time.

The moment when the 1 kHz test signal is completely suppressed is considered to provide t_{on}. The period of time t_1 and t_2 as defined in the table shall be used to define the appropriate template.

The result shall be recorded as frequency difference versus time.

The transmitter shall remain switched on.

The storage oscilloscope shall be set to trigger on the channel corresponding to the amplitude difference (ad) input at a high level, decaying and set so that the triggering occurs at 1 division from the right edge of the display.

The transmitter shall then be switched off. The moment when the 1 kHz test signal starts to rise is considered to provide t_{off}. The period of time t_3 as defined in the table shall be used to define the appropriate template.

The result shall be recorded as frequency difference versus time.

13.8.3 Results required

During the period of time t_1 and t_2, the frequency difference shall not exceed the value of one channel separation. The frequency difference, after the end of t_2, shall be within the limit of the frequency error, as specified in 13.1.3.

During the period of time t_3, the frequency difference shall not exceed the value of half-a-channel separation. Before the start of t_3 the frequency difference shall be within the limit of the frequency error, as specified in 13.1.3.

The required results are illustrated in figure 2.

14 Receiver tests

14.1 Calling sensitivity (7.7.1)

14.1.1 Objective

To measure the calling sensitivity of the receiver, 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 test modulation will produce a bit error rate of 10^{-2}.

14.1.2 Method of measurement

Standard test signal number 2 shall be applied to the receiver input. The input level shall be 0 dBμV under normal test conditions and +6 dBμV under extreme test conditions.

The bit error rate at the output shall be determined as described in 8.8.

The measurement shall be carried out under normal test conditions (8.4) and under extreme test conditions (8.5.1 and 8.5.2 applied simultaneously).

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

14.1.3 Results required

The bit error rate shall be equal to or less than 10^{-2}.

14.2 Dynamic range (7.7)

14.2.1 Objective

To measure the dynamic range of the equipment, which is the range from the minimum to the maximum level of a radiofrequency input signal at which the bit error rate in the output of the receiver does not exceed a specified value.

14.2.2 Method of measurement

A test signal, in accordance with standard test signal number 2, shall be applied to the receiver input. The level of the test signal shall alternate every 10 s between 100 dBμV and 0 dBμV.

The bit error rate at the output of the receiver shall be determined as described in 8.8.

14.2.3 Results required

The bit error rate shall be better than or equal to 10^{-2}.

14.3 Co-channel rejection (7.7.3)

14.3.1 Objective

To measure the co-channel rejection, which characterizes the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal, both signals being at nominal frequency of the receiver.

14.3.2 Method of measurement

The arrangements for applying the test signals shall be in accordance with 8.7.3.

The wanted signal shall be standard test signal number 2. The level of the wanted signal shall be +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 –5 dBμV.

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

The bit error rate at the output of the receiver shall be determined as described in 8.8.

14.3.3 Results required

The bit error rate shall be equal to or less than 10^{-2}.

14.4 Adjacent channel selectivity (7.7.4)

14.4.1 Objective

To measure the adjacent channel selectivity, which characterizes the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal that differs in frequency from the wanted signal by 25 kHz.

14.4.2 Method of measurement

The arrangements for applying the test signals shall be in accordance with 8.7.3.

The wanted signal shall be standard test signal number 2. The level of the wanted signal shall be +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 73 dBμV. The unwanted signal shall be tuned to the centre frequency of the upper adjacent channels.

The bit error rate at the output of the receiver shall be determined as described in 8.8.

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

14.4.3 Results required

The bit error rate shall be equal to or less than 10^{-2}.

14.5 Blocking immunity (7.7.5)

14.5.1 Objective

To measure the blocking immunity, which characterizes the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal with frequencies outside the passband of the receiver.

14.5.2 Method of measurement

The arrangements for applying the test signals shall be in accordance with 8.7.3.

The wanted signal shall be standard test signal number 2. The level of the wanted signal shall be +3 dBμV.

The unwanted signal shall be unmodulated. 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 level of the unwanted signal shall be 93 dBμV.

The bit error rate at the output of the receiver shall be determined as described in 8.8.

14.5.3 Results required

The bit error rate shall be equal to or less than 10^{-2}.

14.6 Intermodulation response (7.7.6)

14.6.1 Objective

To measure the inter-modulation response ratio, which characterizes the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of two or more unwanted signals with a specific frequency relationship to the wanted signal frequency.

14.6.2 Method of measurement

The arrangements for applying the test signals shall be in accordance with 8.7.3. The wanted signal represented by signal generator A shall be at the nominal frequency of the receiver and shall be standard test signal number 2. The level of the wanted signal shall be +3 dBμV.

The unwanted signal from signal generator B shall be unmodulated and adjusted to a frequency 50 kHz above 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 the nominal frequency of the receiver. The input level of each unwanted signal shall be 68 dBμV. The test shall be repeated with the frequency of the unwanted signals below the nominal frequency of the receiver.

The bit error rate at the output of the receiver shall be determined as described in 8.8.

14.6.3 Results required

The bit error rate shall be better than or equal to 10^{-2}.

14.7 Conducted spurious emissions into the antenna (7.7.7)

14.7.1 Objective

Conducted spurious emissions are all internally generated signals conducted to the antenna terminal, irrespective of the frequency.

14.7.2 Method of measurement

The receiver input is connected to the artificial antenna specified in 8.7.4, and the spurious emission is measured, using a selective measuring instrument. The r.m.s. value of any component of the spurious emission shall then be evaluated. The measurement is made over the frequency range from 9 kHz to 2 GHz.

14.7.3 Results required

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

15 Other tests

15.1 Antenna system (7.8)

Manufacturer's declaration.

15.2 Power supply (7.9)

Manufacturer's declaration.

15.3 Compass safe distance

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

16 Safety precautions (7.5)

No damage to the equipment shall occur when the antenna terminals are placed on open circuit or short circuit for a period of at least 5 min in each case.

Check that the EUT is not transmitting during channel switching operation and that operation of the transmit/receive (p.t.t.) control does not cause unwanted emissions. (7.5.2)

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

17 EMC emissions

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

18 EMC immunity

Tests for EMC shall be performed as specified in IEC 60945. These are conducted low-frequency interference, conducted radiofrequency interference, radiated interference, fast transients (bursts), slow transients (surges), power supply short-term variation, power supply failure, and electrostatic discharge. These tests shall use test signal number 1 to demonstrate compliance with the performance criterion. Performance criterion C shall be taken to mean that the functions of the EUT are self-recoverable i.e. without operation of controls.

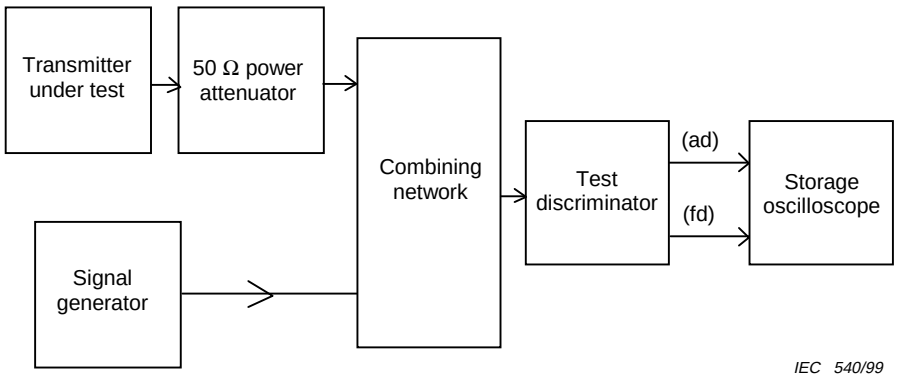
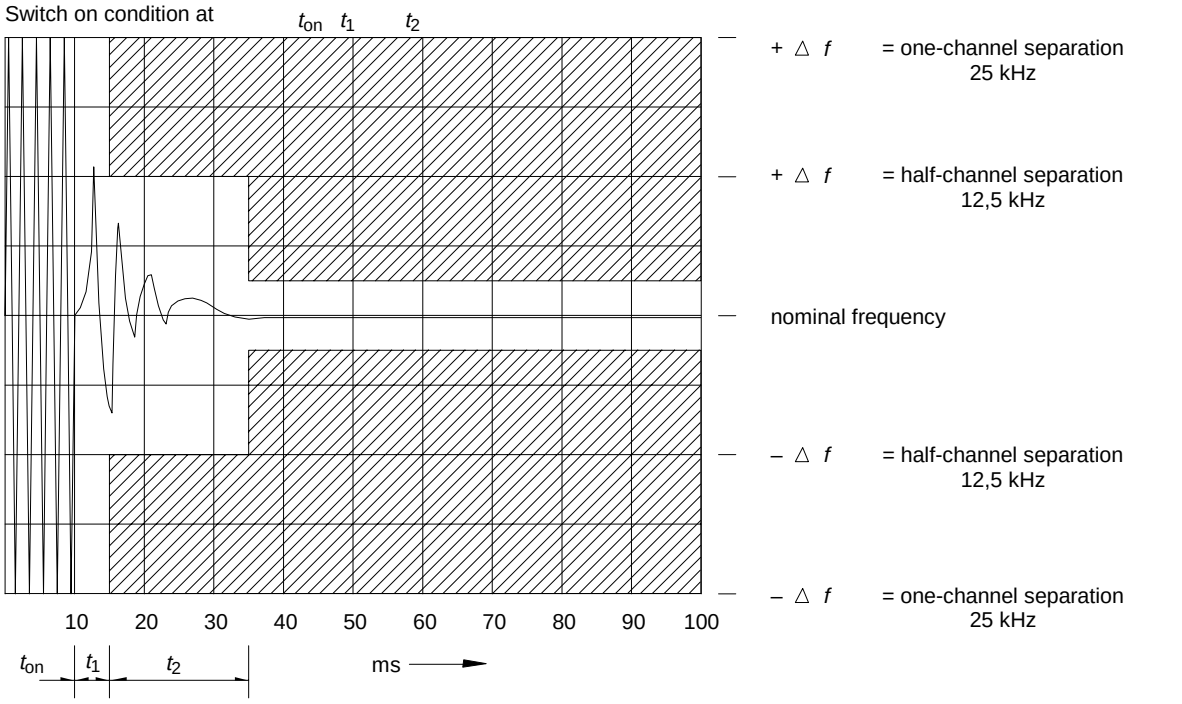


Figure 1 – Test set-up for measuring transient frequency behaviour



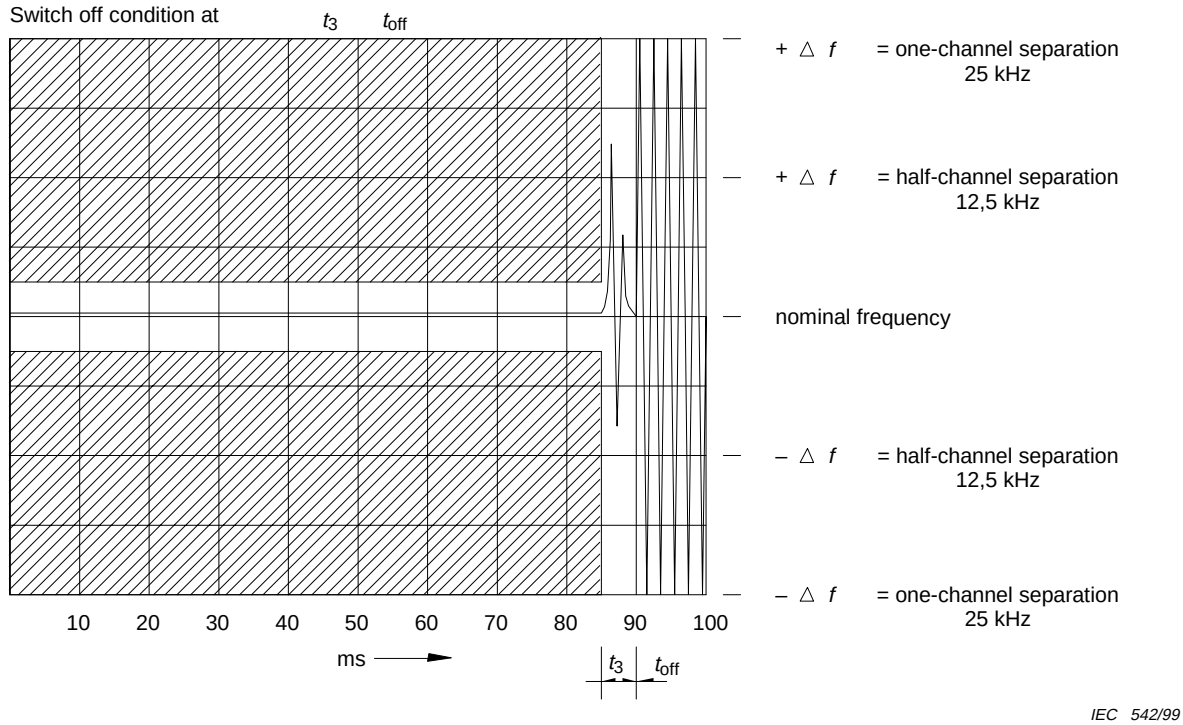


Figure 2 – Storage oscilloscope view t_1, t_2 and t_3

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 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 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.

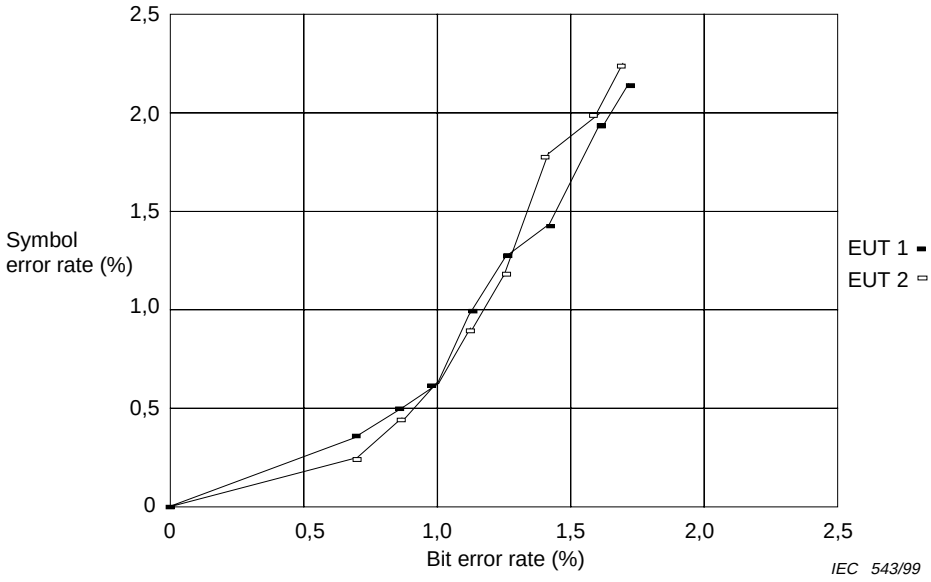


Figure A.1 – Symbol error rate (%) versus bit error rate (%) – Individual call

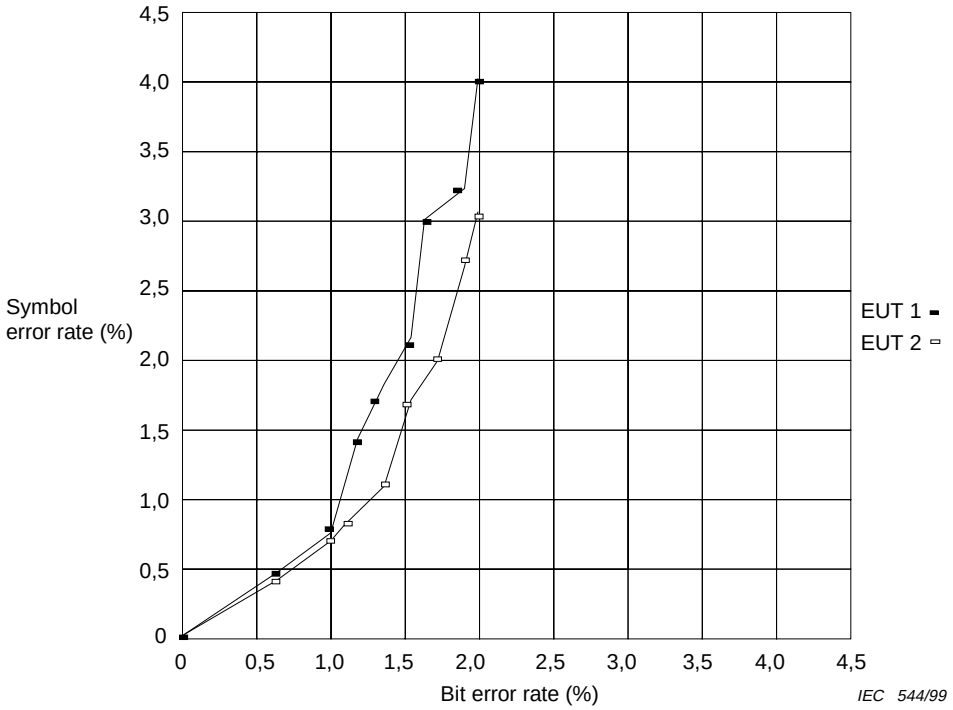


Figure A.2 – Symbol error rate (%) versus bit error rate (%) – Distress call

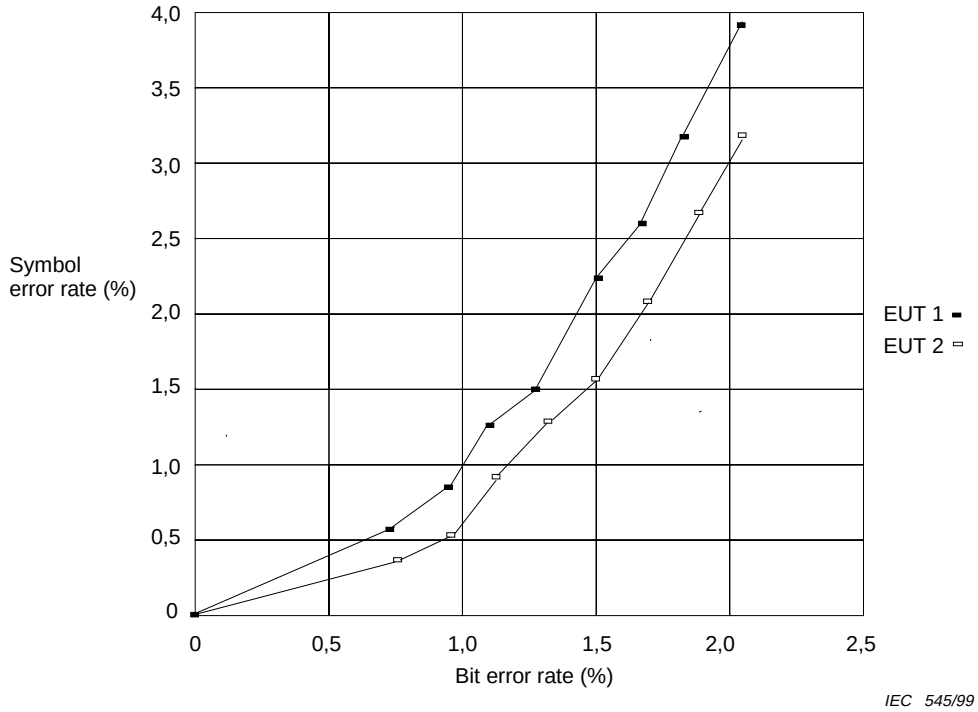


Figure A.3 – Symbol error rate (%) versus bit error rate (%) – All ship call

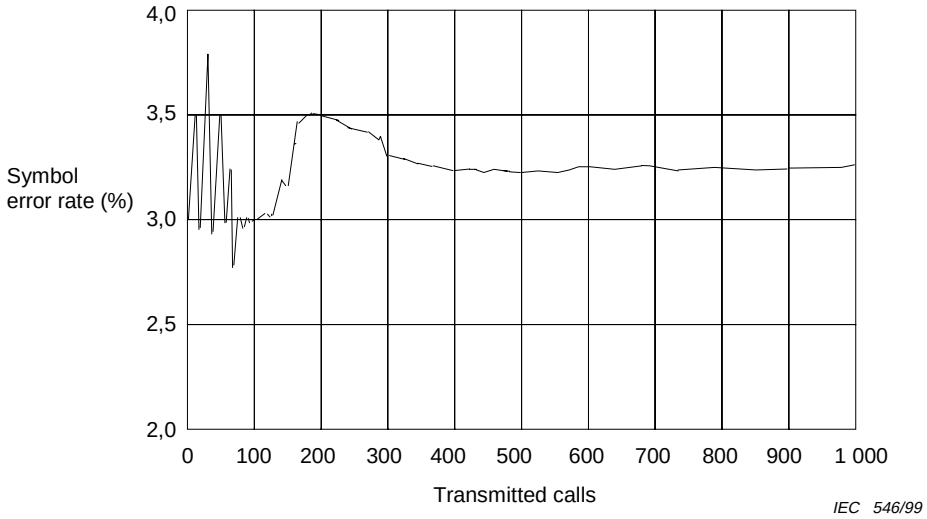


Figure A.4 – Symbol error rate (%) versus transmitted calls (distress call-EUT 1)

Annex B
(normative)

Power measuring receiver specification

B.1 IF filter

The IF filter shall be within the limits specified in figure B.1:

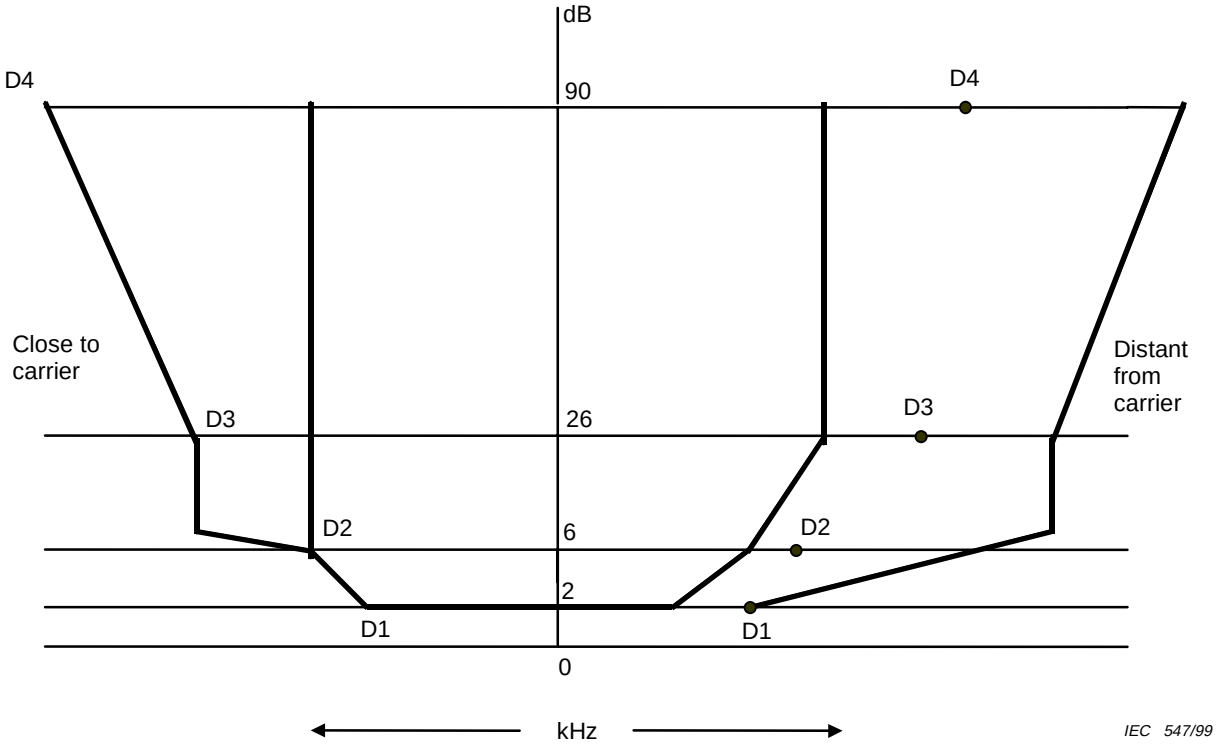


Figure B.1 – IF filter specification

The selectivity characteristics shall maintain the following frequency separations from the nominal centre frequency of the adjacent channel given in table B.1.

Table B.1 – Selectivity characteristic

Frequency separation of filter curve from nominal centre frequency of adjacent channel kHz			
D1	D2	D3	D4
5	8,0	9,25	13,25

The attenuation points shall not exceed the following tolerances:

Table B.2 – Attenuation points close to carrier

Tolerance kHz			
D1	D2	D3	D4
+3,1	±0,1	–1,35	–5,35

Table B.3 – Attenuation points distant from carrier

Tolerance kHz			
D1	D2	D3	D4
±3,5	±3,5	±3,5	+3,5 –7,5

The minimum attenuation of the filter outside the 90 dB attenuation points shall be equal to or greater than 90 dB.

B.2 Attenuation indicator

The attenuation indicator shall have a minimum range of 80 dB and a reading accuracy of 1 dB. With a view to future regulations, an attenuation of 90 dB or more is recommended.

B.3 RMS value indicator

The instrument shall accurately indicate non-sinusoidal signals in a ratio up to 10:1 between the peak value and the r.m.s. value.

B.4 Oscillator and amplifier

The oscillator and the amplifier shall be designed in such a way that measurement of the adjacent channel power of a low-noise unmodulated transmitter, whose self-noise has a negligible influence on the measurement results, yields a measured value of <–90 dB.

Annex C
(informative)

Description of operation of the system

C.1 Introduction

The system is primarily intended to give basic identification information about a ship, mainly name and number, although other information is available, and to give limited tracking capabilities. It employs digital selective calling (DSC) with VHF radio, similar to that used in the Global maritime distress and safety system (GMDSS), and electronic position-fixing equipment such as GPS to provide a position. It is possible to realise the system using the VHF DSC equipment fitted on a vessel for the GMDSS (combined installation), or with a stand-alone transponder. This latter is envisaged as a black box requiring little user involvement.

C.2 VHF channel 70

The system operates on VHF channel 70, which is the frequency reserved for DSC and is watched by all vessels in the GMDSS. Channel 70 is organized on a “transmit when free” basis, but its capacity is recommended by ITU-R M.822 to be limited to 15 %. This ensures that a shore station can reliably receive signals from distant ships which are out of range of one another and therefore unable to organize their transmissions by detecting the channel free. This recommended capacity gives a maximum of 500 calls (1 000 messages) an hour. Half of these calls are assumed to be used by other services using channel 70, particularly public correspondence, which leaves 250 calls an hour available for transponder transmissions.

The limit on call rate determines how the system can be used. In regions of high shipping traffic, use is limited to identifying the ships passing through. This is achieved by polling a small geographical area so that any ship responds once or twice as it steams through the area. In regions of lower traffic density, it is possible to track ships by polling them at intervals of the order of minutes and large geographical areas can be used.

C.3 Ship-to-ship

While shore stations are initiating the polls, the loading on the channel can be controlled. Indiscriminate use of the system by ship stations could quickly overload the channel, particularly in regions with many ships. Ship-to-ship operation is therefore limited firstly to a geographic area of 0,5 square miles and secondly to three attempts in 15 m. This allows the operational requirement to be met of identifying a particular radar response at say 5 miles distance by interrogating the small area around it so that only the wanted ship responds. Further information such as next port and destination which can be obtained by shore stations is not available to ship stations.

C.4 Ship equipment

A combined installation with a GMDSS installation is permitted to respond to polling on channel 70, provided that it then returns to the channel to which it had previously tuned. Thus any other use of the radio will be interrupted for 0,5 s while the transponder response is made. At the low interrogating rates intended, this is found to be a minimal disruption of other use. The system operation may be turned off, but then the times of outages exceeding 15 min are recorded. This is to provide a record for subsequent use if a ship has missed a reporting point, etc.

C.5 Multi-frequency operation

The system is required to operate on a channel other than channel 70 if instructed to do so by a shore station. Subsequent transmission requests in a message will then be made on the other channel. A combined installation will automatically return to channel 70 operation, but a stand-alone transponder will remain on the other channel until instructed to return. In all cases, channel 70 is monitored and instructions on channel 70 respond on channel 70.

———————

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