

# INTERNATIONAL STANDARD

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**62238**

First edition  
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**Maritime navigation and radiocommunication  
equipment and systems –  
VHF radiotelephone equipment incorporating  
Class "D" Digital Selective Calling (DSC) –  
Methods of testing and required test results**



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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**MARITIME NAVIGATION AND RADIOCOMMUNICATION  
EQUIPMENT AND SYSTEMS –****VHF radiotelephone equipment incorporating  
Class “D” Digital Selective Calling (DSC) –  
Methods of testing and required test results**

## FOREWORD

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International Standard IEC 62238 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
80/352/FDIS	80/359/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.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until 2005. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

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

## INTRODUCTION

Equipment designed to this International Standard is intended to provide compatibility with the Global Maritime Distress and Safety System (GMDSS) for fitting to vessels to which the International Convention on the Safety of Life at Sea (SOLAS) 1974 does not apply. Such vessels are typically small commercial vessels, pleasure vessels, fishing vessels, etc.

The equipment does not meet all the requirements of the International Maritime Organization (IMO) for SOLAS vessels. However, it does meet the IMO guidelines for non-SOLAS vessels in that it is capable of maintaining a listening watch on VHF channel 16 simultaneously with a watch on DSC channel 70.

The equipment is further capable of both transmitting and receiving distress alerts by DSC on channel 70, thus providing for the safety of own ship together with the ability to assist other ships in distress.

The emphasis in this standard is on simplicity of operation. The VHF equipment uses DSC controllers based on Class D, which will probably be integrated in the VHF radio equipment but in any event will have the capability to select the radio channels automatically. An input for position information in IEC 61162-1 format is a requirement and the use of automatic position updating is to be encouraged.

Distress calls may only be made by means of a protected dedicated button. Furthermore, channel 16 is required to be selected automatically after transmission of a distress or urgency call.

Position is included in the distress call either through being entered manually or with an internal GPS or an external GPS. Moreover, a DSC expansion sentence is sent after a distress alert to enhance the position resolution to better than 1 nautical mile.

Routine calls require only the input of the called MMSI and a channel number in the case of a ship to ship call. For incoming calls, the radio should be easily configured by the operator to either select automatically or manually the channel number given in the message. Means are provided for the user to enter a temporary group MMSI to permit calling amongst a group of related vessels.

The intended aim of designers of equipment to this international standard is that it should take no longer than 10 min for an operator to learn to use the equipment. This is achieved by the provision of clear simple menus with the most frequently used functions at the top of the menu tree.

As an aid to safety, it is a requirement, in order to prevent the transmission of DSC calls from an unidentifiable ship, that DSC operation is inhibited on a new equipment until the vessel's own MMSI has been entered.

Equipment designed to this standard is fitted with a 50  $\Omega$  external antenna socket or connector for use on board vessels and operates in the bands between 156 MHz and 174 MHz allocated to the maritime mobile service.

Equipment designed to this standard will not necessarily have exposed metal work which is isolated from the power supply. Earthing exposed metal work may cause a terminal of the source of electrical energy to be earthed.



## MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS –

### VHF radiotelephone equipment incorporating Class “D” Digital Selective Calling (DSC) – Methods of testing and required test results

#### 1 Scope

This International Standard covers the minimum requirements for general communication for shipborne fixed installations using a VHF radiotelephone incorporating class “D” Digital Selective Calling.

These requirements include the relevant provisions of the ITU Radio Regulations, ITU-R Recommendations M.493-10 where class D is defined, and incorporate the relevant guidelines of the IMO as detailed in MSC/Circ. 803, MSC/Circ. 862 and Resolution MSC.131(75).

This standard also specifies technical characteristics, methods of measurement and required test results.

Recommended standards for equipment intended to work in high level electromagnetic environments are described and included in annex D.

#### 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

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

IMO Resolution MSC.131(75):2002, *Maintenance of a continuous listening watch on VHF channel 16 by SOLAS ships whilst at sea and installation of VHF DSC facilities on non-SOLAS ships*

IMO MSC/Circ.803: *Participation of non-SOLAS ships in the Global Maritime Distress and Safety System (GMDSS)*

IMO MSC/Circ.862: *Clarifications of certain requirements in IMO performance standards for GMDSS equipment*

ITU Radio Regulations, Appendix S18: 1998, *Table of transmitting frequencies in the band 156 - 174 MHz for stations in the maritime mobile service*

ITU-R Recommendation M.493-10, *Digital selective-calling system for use in the maritime mobile service*

ITU-R Recommendation M.821-1: 1997, *Optional expansion of the digital selective-calling system for use in the maritime mobile service*

ITU-R Recommendation M.825-3, *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.1084-4: 2001, *Interim solutions for improved efficiency in the use of the band 156 -174 MHz by stations in the maritime mobile service*

ITU-R Recommendation M.1371-1: 2001, *Technical characteristics for a universal shipborne automatic identification system using time division multiple access in the VHF maritime mobile band*

ITU-R Recommendation SM.332-4, *Selectivity of receiver*

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

ITU-T Recommendation P.53: 1994, *Psophometer for use on telephone-type circuits*

### **3 Terms, definitions and abbreviations**

For the purposes of this document, the following terms and definitions apply.

#### **3.1 Definitions**

##### **3.1.1**

##### **class D**

equipment intended to provide minimum facilities for VHF DSC distress, urgency and safety as well as routine calling and reception, not necessarily in full accordance with IMO GMDSS carriage requirements for VHF installations (ITU-R Recommendation M.493-10)

##### **3.1.2**

##### **carrier frequency**

the frequency to which the transmitter or receiver is tuned

##### **3.1.3**

##### **frequency deviation**

the difference between the instantaneous frequency of the modulated RF signal and the carrier frequency

##### **3.1.4**

##### **G3E**

phase-modulation (frequency modulation with a pre-emphasis of 6 dB/octave) for speech

##### **3.1.5**

##### **G2B**

phase-modulation with digital information, with a sub-carrier for DSC operation

##### **3.1.6**

##### **modulation index**

the ratio between the frequency deviation and the frequency of the modulation signal

### 3.2 Abbreviations

AIS	Universal shipborne automatic identification system
DSC	Digital selective calling
e.m.f.	electromotive force
EPIRB	Emergency position-indicating radiobeacon
EUT	Equipment under test
FM	Frequency modulation
IF	Intermediate frequency
IMO	International Maritime Organization
MMSI	Maritime mobile service identity
RF	Radio frequency
r.m.s.	root mean square
SINAD	Signal + noise + distortion to noise + distortion
VHF	Very high frequency
VTs	Vessel traffic system

## 4 General and operational requirements

### 4.1 General

The manufacturer shall declare that compliance to the requirements of clause 4 is achieved and shall provide relevant documentation if requested.

### 4.2 Composition

The equipment shall, as a minimum, include

- a VHF radiotelephone transmitter;
- a VHF radiotelephone receiver;
- a channel 70 watchkeeping facility for DSC decoder;
- a DSC encoder; and
- a DSC decoder.

### 4.3 Construction

The mechanical and electrical construction and finish of the equipment shall conform in all respects to good engineering practice, and the equipment shall be suitable for use on board vessels.

All controls shall be of sufficient size to enable the usual control functions to be easily performed and the number of controls should be the minimum necessary for simple and satisfactory operation.

Adequately detailed operating instructions shall be provided with the equipment.

The equipment shall be capable of operating on single frequency and two-frequency channels with manual control (simplex).

The equipment shall be able to operate on channels defined in appendix S18 to the Radio Regulations (see Annex E). Additional VHF channels outside those defined by appendix S18 to the Radio Regulations may also be provided (see for instance Annexes F and G), but means shall be provided to block any of these additional channels, as may be required by appropriate Administrations before installation on board vessels. It shall not be possible for the user to unblock any blocked channels. (See also ITU-R Recommendation M.1084-4.) In the case of an incompatible working channel request, the unit shall reply "Unable to Comply" with 104 as the first telecommand and 108 as the second telecommand.

The equipment shall be so designed that use of channel 70 for purposes other than DSC is prevented.

It shall not be possible to transmit while any frequency synthesizer used within the transmitter is out of lock.

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

#### 4.4 Controls and indicators

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

If the equipment can be operated from more than one position, the control unit provided at the position from where the vessel is normally navigated shall have priority and the individual control units shall be provided with an indicator showing whether the equipment is in operation.

The following controls or functions shall be provided:

- DISTRESS BUTTON (see 4.5.3): the default shall be an undesignated distress message;
- CALL (see 4.5.1): the default (initial display) shall be an individual call;
- CANCEL: to revert to the initial display or to silence the aural alarm and visual indication used to indicate receipt of a DSC alert. The cancel function shall take place automatically after a maximum of 5 min of inactivity;
- ENTER/Accept/OK: for accepting a menu item;
- a means of easily entering a MMSI for calling and manual position information. If a numeric key pad is provided this shall conform to ITU-T Recommendation E.161;
- ALPHA – NUMERIC DISPLAY (see 4.6);
- on/off switch for the entire installation with a visual indication that the installation is in operation;
- a manual non-locking push-to-talk switch to operate the transmitter with a visual indication that the transmitter is activated and facilities to limit the maximum transmission time to 5 min;
- a switch for reducing transmitter output power to no more than 1 W, on both telephony and DSC, with a visual indication that low power is selected. Transmission of DSC distress calls shall always be at full power;
- an audiofrequency power volume control;
- a squelch control;
- a control for dimming to extinction the equipment illumination with the exception of a visual indicator (see 4.5.3).

The equipment shall have means to select manually a channel and shall indicate the designator of the channel at which the installation is set.

All electronic displays, including the channel designator, shall be legible irrespective of the external lighting conditions.

Channel 16 shall be distinctively marked. Selection of channel 16, shall be preferably by readily accessible means (e.g. a distinctively marked key). Selection of Channel 16 by any means shall automatically set the transmitter output power to maximum. This power level may subsequently be reduced by manual user control if required.

Where the capability for automatically switching a radiotelephone channel on receipt of a DSC call exists, a means for disabling that capability should be provided. This capability should be provided for all calls other than individual station calls of category distress or urgency.

#### **4.5 Facilities for coding and decoding of DSC**

##### **4.5.1 Call functions**

The facilities for coding and composition of calls shall be so arranged that it is possible for the operator quickly and precisely to enter a call. The types of DSC calls provided in this equipment are specified in annex A.

The CALL functions (see 4.4) shall permit selection of the following functions:

- INDIVIDUAL: for making a call to a specific MMSI;
- GROUP: for making a call to a specific Group MMSI (see 5.4);
- ALL SHIPS URGENCY/SAFETY: for making all ships calls;
- RECEIVED CALLS: for retrieving stored incoming DSC calls;
- OTHER: for equipment housekeeping functions.

If INDIVIDUAL is selected, either a MANUAL call (see 4.5.2) or a DIRECTORY call shall be selected. The DIRECTORY list shall have a facility for at least 10 entries. Their MMSIs shall be programmable.

##### **4.5.2 MANUAL calls**

The MANUAL call facility shall permit the entry of a MMSI. If the called station is a coast station (i.e. MMSI commencing 00) no further information shall be requested from the operator. If the called station is a ship station the equipment shall request input of a channel number. The equipment shall assist the operator by suggesting a suitable inter-ship channel suitable for the vessels area of operation.

NOTE In Appendix S18 of the Radio Regulations channels 6, 8, 72 and 77 are reserved solely for inter-ship communications. Channels 9, 10, 13, 15, 17, 67, 69 and 73 may also be used for inter-ship communications but are also available for port operations and ship movement.

##### **4.5.3 Distress calls**

It shall only be possible to transmit distress DSC calls by means of a single dedicated button which is used for no other purpose. This button shall not be any key of ITU-T Recommendation E.161 digital input panel or an ISO keyboard provided on the equipment. This button shall be red in colour and marked "DISTRESS". Where a non-transparent protective lid or cover is used, it shall also be marked "DISTRESS". The cover shall be protected against inadvertent operation with a spring loaded lid or cover permanently attached to the equipment by, for example hinges. It shall not be necessary for the user to remove seals or to break the lid or cover in order to operate the distress button.

The operation of the distress button shall generate a visible and audible indication (see 5.6.3). The distress button shall be kept pressed for at least 3 s. A flashing light and an intermittent acoustic signal shall start immediately. After the 3 s, the transmission of the distress alert is initiated and the indication shall become steady.

The distress alert initiation shall require at least two independent actions. Lifting the protective lid or cover is considered as the first action. Pressing the distress button is considered as the second independent action.

It shall be possible to select the nature of distress prior to initiating the transmission of a distress call. The default nature of distress shall be the undesignated distress. The equipment shall be capable of receiving and displaying any designated nature of distress, but shall not be capable of transmitting a nature of distress of EPIRB (symbol 112).

Initiation of a distress call shall automatically have priority over any other operation of the equipment. The equipment shall automatically select channel 70 and the maximum transmitter power.

The distress call shall automatically be transmitted five times in succession with no intervals between the individual calls so that bit synchronization between the transmitter and receiver of the call can be maintained. Each call shall include the appropriate dot pattern.

Following the distress call sequence, a DSC expansion message giving enhanced position resolution according to ITU-R Recommendation M.821-1 shall be transmitted.

After the transmission of the distress call sequence, including the DSC expansion message, the equipment shall automatically tune to channel 16 and select the maximum transmitter power.

#### **4.5.4 ALL SHIPS calls**

It shall only be possible to transmit ALL SHIPS URGENCY and ALL SHIPS SAFETY calls by means of deliberate actions, such as two levels of menu instructions.

After the transmission of the all ships call, the equipment shall automatically tune to channel 16 and select the maximum transmitter power.

#### **4.5.5 Incoming calls**

The DSC equipment shall be provided with suitable facilities for converting incoming calls with relevant address content to visual form in plain language. The contents of at least the last 10 received DSC calls shall be stored in the RECEIVED CALL menu.

The radiotelephone shall be capable of automatically switching to any channel identified in an incoming call. In the case of incoming distress and urgency calls the radiotelephone shall be capable of automatically switching to channel 16 and automatically selecting the maximum transmitter power. The user shall be provided with a visual indication that a channel change is requested.

#### **4.5.6 Other calls**

If automatic response to polling or position reporting calls is included, means for disabling those responses shall be provided.

### **4.6 DSC display**

The equipment shall be provided with facilities which show the functions currently available, prompts the operator if an incorrect operation is attempted, displays error messages and displays incoming and logged calls.

The equipment shall be provided with facilities for visual indication, and possible manual correction of the user programmable information content of the call before the call is sent.

There shall be an indication that unread received (see 4.5.5) messages are present in memory.

Display of geographic position and time shall be readily available. The equipment shall be provided with facilities to display the last entered position (see 5.5). The DSC display should be capable of continuously displaying a complete enhanced position according to ITU-R M.821.

For DSC displays located on the handset, the display should be easily read from a distance of 40 cm. For DSC displays located on the transceiver unit, the display should be easily read from 85 cm.

#### **4.7 Handset and loudspeaker**

The equipment shall be fitted with a telephone handset or microphone, and an integral loudspeaker and/or a socket for an external loudspeaker. Where there are connections to external loudspeakers, these shall also relay acoustic alarms.

During transmission in simplex operation the receiver output shall be muted.

#### **4.8 Safety precautions**

Measures shall be taken to protect the equipment against the effects of excessive current or excessive voltage.

Measures shall be taken to prevent any damage that might arise from an accidental reversal of polarity of the electrical power source.

Means shall be provided for earthing exposed metallic parts of the equipment.

The components and wiring in which the a.c. or d.c. voltage (other than radio-frequency voltage), produce, singly or in combination, peak voltages in excess of 50 V, shall be protected against any accidental access and shall be automatically isolated from all electrical power sources if the protective covers are removed. Alternatively, the equipment shall be constructed in such a way as to prevent access to components operating at such voltages unless an appropriate tool is used such as a nut-spanner or screwdriver. Conspicuous warning labels shall be affixed both inside the equipment and on the protective covers.

No damage to the equipment shall occur when the antenna terminals are placed on open circuit or short circuit for the period permitted by the push-to-talk switch in 4.4.

In order to provide protection against damage due to the build up of static voltages at the antenna terminals, there shall be a d.c. path from the antenna terminals to chassis not exceeding 100 k $\Omega$ .

The information in programmable memory devices and the vessel's identity and information inherent to the DSC process shall be stored in non-volatile memory devices.

#### **4.9 Labelling**

All controls, instruments, indicators and terminals shall be clearly labelled.

Details of the power supply from which the equipment is intended to operate shall be clearly indicated on the equipment.

The compass safe distance shall be stated on the equipment or in the user document as described in IEC 60945.



#### **4.10 Warm up**

After being switched on, the equipment shall be operational within 5 s.

### **5 Technical requirements**

#### **5.1 Switching time**

The channel switching arrangement shall be such that the time necessary to change over from using one of the channels to using any other channel does not exceed 5 s.

The time necessary to change over from transmission to reception or vice versa, shall not exceed 0,3 s.

#### **5.2 Class of emission and modulation characteristics**

The equipment shall use phase modulation, G3E (frequency modulation with pre-emphasis of 6 dB/octave) for speech, and G2B for DSC signalling.

The equipment shall be designed to operate with a channel separation of 25 kHz. Other channel spacings are allowed if permitted by appropriate national Administrations (see ITU-R Recommendation M.1084-4).

#### **5.3 Facilities for DSC transmission and reception**

##### **5.3.1 General**

The equipment shall include the necessary facilities for coding and transmission of DSC on channel 70 and for decoding and conversion of the information content of received DSC to visual form in plain language.

The watchkeeping facility part of the DSC equipment shall be designed for continuous DSC monitoring on channel 70 but need not operate when the transmitter is in use.

##### **5.3.2 Decoding**

The DSC equipment shall be so designed that in the decoding process use shall be made of the phasing sequence, of parity bits for error detection, time diversity repetitions and error check characters in the received call as specified in ITU-R Recommendation M.493-10.

##### **5.3.3 Free channel transmission**

The DSC equipment shall be provided with facilities which, except for distress calls, automatically delay the transmission of DSC until the calling channel 70 is free.

##### **5.3.4 Automatic acknowledgement**

The equipment shall not be provided with facilities for automatic transmission of acknowledgements to routine calls.

##### **5.3.5 Automatic re-transmission of distress calls**

Where no DSC distress acknowledgement is received, the equipment shall automatically retransmit the distress call attempt on channel 70 after a random delay of between 3,5 min and 4,5 min from the beginning of the previous call.

After the transmission of each distress call attempt the equipment shall automatically re-tune to channel 16 and select the maximum transmitter power.



This sequence shall be continued until a DSC distress acknowledgement has been received, or until the automatic transmission of the distress call is discontinued manually. This manual operation shall not interrupt the transmission of any distress call attempt in progress.

Means shall be provided for transmitting the distress call attempt again by manual intervention at any time.

A visual indication shall be provided that a distress alert is in automatic retransmit mode. An audible indication shall be provided during retransmission.

#### **5.4 Ships identity – MMSI and Group MMSI**

The equipment shall be capable of storing permanently the ship's 9-digit Maritime Mobile Service Identity (MMSI) number which shall be inserted automatically in the call. The 10th digit shall be added automatically and set to zero.

It shall not be possible to transmit a DSC call until the ship's MMSI has been stored.

After the MMSI has been stored, it shall not be possible to change the identity number using any combination of operator controls. The ship's MMSI shall be readily accessible to the operator, either displayed at equipment power-up, or by a simple action of the operator.

Facilities shall be provided to permit the operator to program and store a Group MMSI number to enable the equipment to recognize calls addressed to both the ship's MMSI and the Group MMSI. These facilities shall limit the number of operator programmable digits to 8 and the leading zero shall be automatically inserted by the equipment.

#### **5.5 Entry of position information**

Means shall be provided for manual entry of the geographical position information and of the time when this position information was valid. In addition, facilities for automatic entry and encoding of the geographical position and time information shall be provided. Such facilities, if provided externally shall conform with IEC 61162-1. As a minimum, the sentences GLL, GGA, RMC and GNS shall be recognized.

No connection of, or failure within, any connected equipment shall disable the DSC equipment.

When no position information has been entered either manually or due to the failure of any automatic system or the absence of a valid external data stream (IEC 61162-1), the operator shall be aurally and visually prompted for a manual input of position. This prompt shall be repeated every 4 h.

If the position information has not been updated for 23,5 h, the position shall default to the repeated digit "9" as specified in ITU-R Recommendation M.493-10.

#### **5.6 Alarm circuits for incoming calls**

##### **5.6.1 Distress and urgency**

The equipment shall be provided with a specific acoustic alarm and a visual indication, activated automatically when a call with format specifier distress or category distress or urgency has been received. It shall not be possible to disable these alarm circuits.

The alarm for distress and urgency calls should be distinguishable from the tone for safety and routine calls. The alarm should not be activated where duplicate distress relay calls are received within 1 h. A duplicate distress relay call is one having format specifier all ships or geographic area that contains identical message information to that of the initiating distress alert, and an identical distress MMSI.

### **5.6.2 Other categories**

The equipment shall be provided with an acoustic alarm and a visual indication, activated automatically on receipt of calls of categories other than distress and urgency. It shall not be possible to disable the acoustic alarm circuit.

### **5.6.3 Cancellation of alarms**

A means of manual cancellation of alarms shall be provided. In the event that an alarm is not cancelled manually, then automatic cancellation shall take place after 2 min.

### **5.6.4 Acoustic alarm power**

The acoustic alarm shall initially be of a power that is clearly distinguishable, but not interfere with, radiotelephone communications. If not manually cancelled within 10 s, the power should rise to a level of at least 80 dB(A) at a distance of 1 m from the equipment before automatic cancellation.

## **5.7 Multiple watch facilities**

### **5.7.1 General**

The VHF radiotelephone equipment may be provided with multiple watch facilities on traffic channels but operation using DSC shall always take precedence.

### **5.7.2 Scanning provisions**

Equipment having multiple watch facilities shall as a minimum comply with the following:

- the equipment shall include a provision for the automatic scanning of a priority channel and one additional channel. Facilities for the automatic sequential change of the additional channel may be provided;
- the priority channel is that channel which will be sampled even if there is a signal on the additional channel and on which the receiver will lock during the time a signal is detected;
- the additional channel is that channel which will be monitored during the periods the equipment is not sampling or receiving signals on the priority channel;
- provision shall be included to switch the scanning facility on and off by means of a manually operated control. In addition, it shall be ensured that the receiver remains on the same channel as the transmitter for the entire duration of any communication, for example the scanning facility may be switched off automatically when the handset is off its hook;
- selection of the additional channel and selection, if provided, of the priority channel shall be possible at the operating position of the receiver or transceiver. If selection of the priority channel is not provided, the priority channel shall be channel 16;
- when the scanning facility is in operation, the channel number of both channels on which the equipment is operating shall be indicated;
- in a transceiver, transmission shall not be possible when the scanning facility is operating. When the scanning facility is switched off, both transmitter and receiver shall be tuned automatically to the selected additional channel;
- a transceiver shall be provided with a single manual control (e.g. push-button) in order to switch the equipment quickly for operation on the priority channel;
- at the operating position of a transceiver, the selected additional channel shall be clearly indicated as being the operational channel of the equipment.

Additional scanning modes are permitted.

### 5.7.3 Scanning characteristics

When the scanning facility is switched on, the priority channel shall be sampled with a sampling period of not more than 2 s.

If a signal is detected on the priority channel the receiver shall remain on this channel for the duration of that signal.

If a signal is detected on the additional channel, the sampling of the priority channel shall continue, thus interrupting the reception on the channel for periods as short as possible and not greater than 150 ms.

The design of the receiver shall provide for its proper functioning during the period the priority channel is sampled since the receiving conditions on the priority channel may differ from those on the additional channel.

In the absence of a signal on the priority channel, and, during reception of a signal on the additional channel, the duration of each listening period on this channel shall be at least 850 ms.

Means shall be provided to indicate the channel on which a signal is being received.

### 5.8 Built-in test

A built-in test facility for the DSC processor shall be provided.

## 6 General conditions of measurement

### 6.1 Arrangements for test signals applied to the receiver input

Test signal sources shall be connected to the receiver input in such a way that the impedance presented to the receiver input is 50  $\Omega$ , irrespective of whether one or more test signals are applied to the receiver simultaneously.

The levels of the test signals shall be expressed in terms of the electromotive force (e.m.f.) at the terminals to be connected to the receiver.

The nominal frequency of the receiver is the carrier frequency of the selected channel.

### 6.2 Squelch

Unless otherwise specified, the receiver squelch facility shall be made inoperative for the duration of the conformance tests.

### 6.3 Normal test modulation

For normal test modulation, the modulation frequency shall be 1 kHz and the frequency deviation shall be  $\pm 3$  kHz.

For DSC conformance testing and maintenance purposes, the equipment shall have facilities not accessible to the operator to generate a continuous B or Y signal and dot pattern.

Additionally for conformance testing, the VHF equipment shall have facilities not accessible to the operator for generating an unmodulated carrier.

#### **6.4 Artificial antenna**

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

#### **6.5 Arrangements for test signals applied to the transmitter input**

For the purposes of this international standard, the audiofrequency modulating signal applied to the transmitter shall be produced by a signal generator applied to the connection terminals replacing the microphone transducer.

#### **6.6 Test channels**

Conformance tests shall be made on channel 16 for voice and channel 70 for DSC tests, unless otherwise stated.

#### **6.7 Generation and examination of the digital selective call signal**

During conformance tests DSC signals generated by the equipment under test shall be examined for correct format and phasing. The equipment used for this purpose should be capable of decoding the DSC call and displaying the content of the sentence as 10 bit symbols as well as the correctly decoded message. A means to produce a hard copy of the results shall be provided.

In addition, a DSC generator shall be used to provide DSC calls to the equipment under test. This generator shall be capable of generating both correctly formatted calls as well as calls containing bit errors in the primary code or the error check character. Tests shall be carried out to determine that the correct use of the error correction as defined in ITU-R M.493-10.

The test report shall identify the means used to determine the validity of the transmitted calls and the tests carried out to determine the ability of the receiver to provide maximum utilization of the received signal.

#### **6.8 Standard test signals for DSC**

The standard test signal for a VHF DSC decoder shall be a phase-modulated signal at VHF channel 70 with modulation index = 2. The modulating signal shall have a nominal frequency of 1 700 Hz and a frequency shift of  $\pm 400$  Hz with a modulation rate of 1 200 baud.

Standard test signals shall consist of a series of identical call sequences, each of which contain a known number of information symbols (format specifier, address, category, identification, etc. of ITU-R Recommendation M.493-10).

Standard test signals shall be of sufficient length for the measurements to be performed or it shall be possible to repeat them without interruption when making the measurements.

#### **6.9 Determination of the symbol error ratio in the output of the receiving part**

The information content of the decoded call sequence displayed at the readout device of the receiving part shall be divided into blocks, each of which corresponds to one information symbol in the applied test signal (see 6.8). The total number of incorrect information symbols relative to the total number of information symbols shall be registered. In this standard, bit error ratio measurements are taken to be equivalent to symbol error ratio measurements.

## 6.10 Measurement uncertainty and interpretation of the measured results

### 6.10.1 Measurement uncertainty

**Table 1 – Maximum values of absolute measurement uncertainties**

Radio Frequency (RF)	$\pm 1 \times 10^{-7}$
RF power/level	$\pm 0,75$ dB
Maximum frequency deviation: within 300 Hz to 6 kHz of audiofrequency	$\pm 5$ %
within 6 kHz to 25 kHz of audiofrequency	$\pm 3$ dB
Deviation limitation	$\pm 5$ %
Adjacent channel power	$\pm 5$ dB
Conducted spurious emission of transmitter	$\pm 4$ dB
Audio output power	$\pm 0,5$ dB
Amplitude characteristics of receiver limiter	$\pm 1,5$ dB
Sensitivity at 20 dB SINAD	$\pm 3$ dB
Conducted emission of receiver	$\pm 3$ dB
Two-signal measurement	$\pm 4$ dB
Three-signal measurement	$\pm 3$ dB
Transmitter transient time	$\pm 20$ %
Transmitter transient frequency	$\pm 250$ Hz

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

### 6.10.2 Interpretation of the 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;
- the recorded value of the measurement uncertainty shall be, for each measurement, equal to or lower than the figures in table 1.

## 6.11 Test conditions, power sources, and ambient temperatures

### 6.11.1 Normal and extreme test conditions

Conformance tests shall be made under normal test conditions and also, where stated, under extreme test conditions (see 6.13.1 and 6.13.2 applied simultaneously).

### 6.11.2 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 6.12.2 and 6.13.2.

The internal impedance of the test power source shall be low enough for its effect on the test results to be negligible. For the purpose of testing, the power source voltage shall be measured at the input terminals of the equipment.

During testing, the power source voltages shall be maintained within a tolerance of  $\pm 3\%$  relative to the voltage level at the beginning of each test.

## **6.12 Normal test conditions**

### **6.12.1 Normal temperature and humidity**

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

- temperature:  $+15\text{ }^{\circ}\text{C}$  to  $+35\text{ }^{\circ}\text{C}$ ;
- relative humidity: 20 % to 75 %.

Where the relative humidity is less than 20 %, it shall be stated in the test report.

### **6.12.2 Normal power sources**

#### **6.12.2.1 Battery power source**

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

#### **6.12.2.2 Other power sources**

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

## **6.13 Extreme test conditions**

Unless otherwise stated, the extreme test conditions means that the EUT shall be tested at the upper temperature and at the upper limit of the supply voltage applied simultaneously, and at the lower temperature and the lower limit of the supply voltage applied simultaneously.

### **6.13.1 Extreme temperatures**

For tests at extreme temperatures, measurements shall be made in accordance with 6.14, at a lower temperature of  $-15\text{ }^{\circ}\text{C}$  and an upper temperature of  $+55\text{ }^{\circ}\text{C}$ .

### **6.13.2 Extreme values of test power sources**

#### **6.13.2.1 Battery power source**

Where the equipment is designed to operate from a battery, the extreme test voltages shall be 1,3 times and 0,9 times the nominal voltage of the battery (12 V, 24 V, etc.).

#### **6.13.2.2 Other power sources**

For operation from other sources, the extreme test voltages shall be advised by the equipment manufacturer.

#### 6.14 Procedure for tests at extreme temperatures

The equipment shall be switched off during the temperature stabilizing periods.

Before conducting tests at the upper temperature, the equipment shall be placed in the test chamber and left until thermal equilibrium is reached. The equipment shall then be switched on in the high power transmit condition for the period permitted by the push-to-talk switch in 4.4. The equipment shall meet the requirements of this standard after this period.

For tests at the lower temperature, the equipment shall be left in the test chamber until thermal equilibrium is reached and shall then be switched to the standby or receive position for 1 min, after which the equipment shall meet the requirements of this standard.

### 7 Environmental tests

#### 7.1 Introduction

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

#### 7.2 Procedure

Unless otherwise stated, the EUT 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 (see 6.12.2).

#### 7.3 Performance check

Where the term “performance check” is used, this shall be taken to mean a visual inspection of the equipment, a test of the transmitter output power and frequency error, and the receiver sensitivity to show that the equipment is functioning and that there is no visible damage or deterioration.

a) For the transmitter:

The transmitter shall be connected to the artificial antenna (see 6.4) and tuned to channel 16. The measurements shall be made in the absence of modulation with the power switch set at maximum. The output power shall be between 6 W and 25 W, and the frequency error shall be less than  $\pm 1,5$  kHz.

b) For the radiotelephone receiver:

A test signal (see 6.3) with a level of +12 dB $\mu$ V shall be applied to the receiver input as in 9.3.2. The SINAD ratio at the receiver output shall be equal to or greater than 20 dB.

c) For the DSC receiver:

A standard DSC test signal (see 6.8) with a level of +6 dB $\mu$ V shall be applied to the receiver input. The symbol error ratio in the decoder output shall be equal to or less than  $10^{-2}$ .

#### 7.4 Vibration test

The vibration test shall be performed as in IEC 60945.

#### 7.5 Temperature tests

The dry heat cycle shall be performed as in IEC 60945.

The damp heat cycle shall be performed as in IEC 60945.

The low temperature cycle shall be performed as in IEC 60945.

## **8 Transmitter**

All tests on the transmitter shall be carried out with the output power switch set at its maximum except where otherwise stated.

### **8.1 Frequency error**

#### **8.1.1 Definition**

The frequency error is the difference between the measured carrier frequency and its nominal value.

#### **8.1.2 Method of measurement**

The carrier frequency shall be measured in the absence of modulation, with the transmitter connected to an artificial antenna (see 6.4) and tuned to channel 16.

Measurements shall be made under normal test conditions (see 6.12) and under extreme test conditions (see 6.13.1 and 6.13.2 applied simultaneously).

This test shall be carried out with the output power switch being set at both maximum and minimum.

#### **8.1.3 Limits**

The frequency error shall be within  $\pm 1,5$  kHz.

### **8.2 Carrier power**

#### **8.2.1 Definition**

The carrier power is the mean power delivered to the artificial antenna during one radio frequency cycle in the absence of modulation.

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

#### **8.2.2 Method of measurement**

The transmitter shall be connected to an artificial antenna (see 6.4) and the power delivered to this artificial antenna shall be measured. The measurements shall be made on channel 16, the highest frequency channel and the lowest frequency channel under normal test conditions (see 6.12) and channel 16 under extreme test conditions (see 6.13.1 and 6.13.2 applied simultaneously).

During the test on channel 16, a check should be made that the power output falls to zero after 5 min and before 6 min of continuous transmission.

#### **8.2.3 Limits**

##### **8.2.3.1 Normal test conditions**

With the output power switch set at maximum, the carrier power shall remain between 6 W and 25 W and be within  $\pm 1,5$  dB of the rated output power under normal test conditions. The output power shall never, however, exceed 25 W.



With the output power switch set at minimum, the carrier power shall remain between 0,1 W and 1 W.

### **8.2.3.2 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, –3 dB of the rated output power under extreme conditions. The output power shall never however exceed 25 W.

With the output power switch set at minimum, the carrier power shall remain between 0,1 W and 1 W.

## **8.3 Frequency deviation**

### **8.3.1 Definition**

For the purposes of this standard, the frequency deviation is the difference between the instantaneous frequency of the modulated radio frequency signal and the carrier frequency.

### **8.3.2 Maximum permissible frequency deviation**

#### **8.3.2.1 Method of measurement**

The frequency deviation shall be measured at the output with the transmitter connected to an artificial antenna (see 6.4) and tuned to channel 16, by means of a deviation meter capable of measuring the maximum deviation, including that due to any harmonics and intermodulation products which may be generated in the transmitter.

The modulation frequency shall be varied between 100 Hz and 3 kHz. The level of this test signal shall be 20 dB above the level which produces normal test modulation (see 6.3). This test shall be carried out with the output power switch set at both maximum and minimum.

#### **8.3.2.2 Limits**

The maximum frequency deviation shall be  $\pm 5$  kHz.

### **8.3.3 Reduction of frequency deviation at modulation frequencies above 3 kHz**

#### **8.3.3.1 Method of measurement**

The transmitter shall operate under normal test conditions (see 6.12) connected to a load as specified in 6.4.

The transmitter shall be modulated by the normal test modulation (see 6.3) and tuned to channel 16. With the input level of the modulation signal being kept constant, the modulation frequency shall be varied between 3 kHz and 25 kHz and the frequency deviation shall be measured.

#### **8.3.3.2 Limits**

For modulation frequencies between 3 kHz and 6 kHz the frequency deviation shall not exceed the frequency deviation with a modulation frequency of 3 kHz. For a modulation frequency of 6 kHz, the frequency deviation shall not exceed  $\pm 1,5$  kHz, as shown in Figure 1.

For modulation frequencies between 6 kHz and 25 kHz, the frequency deviation shall not exceed that given by a linear response of frequency deviation (in dB) against modulation frequency, starting at the point where the modulation frequency is 6 kHz and the frequency deviation is  $\pm 1,5$  kHz and inclined at 14 dB/octave, with the frequency deviation diminishing as the modulation frequency increases, as shown in Figure 1 as far as practicable.

## **8.4 Sensitivity of the modulator, including microphone**

### **8.4.1 Definition**

This characteristic expresses the capability of the transmitter to produce sufficient modulation when an audiofrequency signal corresponding to the normal mean speech level is applied to the microphone.

### **8.4.2 Method of measurement**

An acoustic signal with a frequency of 1 kHz and a sound level of 94 dB(A) shall be applied to the microphone. The resulting deviation shall be measured. This test shall be repeated at frequencies of 300 Hz and 500 Hz.

### **8.4.3 Limits**

The resulting frequency deviation shall be between  $\pm 2,5$  kHz and  $\pm 4,5$  kHz.

## **8.5 Audiofrequency response**

### **8.5.1 Definition**

The audiofrequency response is the frequency deviation of the transmitter as a function of the modulating frequency.

### **8.5.2 Method of measurement**

A modulating signal at a frequency of 1 kHz shall be applied to the transmitter and the deviation shall be measured at the output. The audio input level shall be adjusted so that the frequency deviation is  $\pm 1$  kHz. This is the reference point in Figure 2 (1 kHz corresponds to 0 dB).

The modulation frequency shall then be varied between 300 Hz and 3 kHz, with the level of the audiofrequency signal being kept constant and equal to the value specified above.

### **8.5.3 Limit**

The audiofrequency response shall be within +1 dB and –3 dB of a 6 dB/octave line passing through the reference point (see Figure 2).

## **8.6 Audiofrequency harmonic distortion of the emission**

### **8.6.1 Definition**

The harmonic distortion of the emission modulated by any audiofrequency signal is defined as the ratio, expressed as a percentage, of the root mean square (r.m.s.) voltage of all the harmonic components of the fundamental frequency to the total r.m.s. voltage of the signal after linear demodulation.

### **8.6.2 Method of measurement**

The RF signal produced by the transmitter shall be applied via an appropriate coupling device to a linear demodulator with a de-emphasis network of 6 dB/octave. This test shall be carried out with the output power switch at both maximum and minimum.

#### **8.6.2.1 Normal test conditions**

Under normal test conditions (see 6.12), the RF signal shall be modulated successively at frequencies of 300 Hz, 500 Hz and 1 kHz with a constant modulation index of 3.

The distortion of the audiofrequency signal shall be measured at all the frequencies specified above.

### 8.6.3 Limits

The harmonic distortion shall not exceed 10 %.

## 8.7 Adjacent channel power

### 8.7.1 Definition

The adjacent channel power is that part of the total power output of a transmitter under defined conditions of modulation which 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.

### 8.7.2 Method of measurement

The adjacent channel power can be measured with a power measuring receiver which conforms to annex B (referred to in 8.7.2 and annex B as the “receiver”) ITU-R Recommendation SM.332-4:

- a) the transmitter shall be operated with the output power switch at maximum 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  $\Omega$  and the level at the “receiver” input is appropriate;
- b) with the transmitter unmodulated, 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) the transmitter shall be modulated with 1,25 kHz at a level which is 20 dB higher than that required to produce  $\pm 3$  kHz deviation;
- e) the “receiver” variable attenuator shall be adjusted to obtain the same meter reading as in step b) or a known relation to it;
- f) the ratio of adjacent channel power to carrier power is the difference between the attenuator settings in steps b) and e), corrected for any differences in the reading of the meter;
- g) the measurement shall be repeated with the “receiver” tuned to the other side of the carrier.

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.

### 8.7.3 Limits

The adjacent channel power shall not exceed a value of 70 dB below the carrier power of the transmitter without any need to be below 0,2  $\mu$ W.

## 8.8 Conducted spurious emissions conveyed to the antenna

### 8.8.1 Definition

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

### 8.8.2 Method of measurement

Conducted spurious emissions shall be measured with the unmodulated transmitter connected to the artificial antenna (see 6.4).

The measurements shall be made over a range from 9 kHz to 2 GHz, excluding the channel on which the transmitter is operating and its adjacent channels.

The measurements for each spurious emission shall be made using a tuned radio measuring instrument or a spectrum analyzer.

### 8.8.3 Limit

The power of any conducted spurious emission on any discrete frequency shall not exceed 0,25  $\mu$ W.

## 8.9 Transient frequency behaviour of the transmitter

### 8.9.1 Definitions

The transient frequency behaviour of the transmitter is the variation in time of the transmitter frequency difference from the nominal frequency of the transmitter when the RF output power is switched on and off (see Figure 4).

- $t_{on}$  according to the method of measurement described in 8.10.2 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 finishing according to Table 2;
- $t_2$  period of time starting at the end of  $t_1$  and finishing according to Table 2;
- $t_{off}$  switch-off instant defined by the condition when the nominal power falls below 0,1 % of the nominal power;
- $t_3$  period of time that finishing at  $t_{off}$  and starting according to Table 2.

**Table 2 – Transmitter transient timing (ms)**

$t_1$	5,0
$t_2$	20,0
$t_3$	5,0

NOTE 1 During the periods  $t_1$  and  $t_3$  the frequency difference should not exceed the value of 1 channel separation.

NOTE 2 During the period  $t_2$  the frequency difference should not exceed the value of half a channel separation.

### 8.9.2 Method of measurement

Two signals shall be connected to the test discriminator via a combining network (see 6.1).

The transmitter shall be connected to a 50  $\Omega$  power attenuator.

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  $\pm 25$  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) and the frequency difference (fd) (see Figure 3) 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  $\pm 25$  kHz.

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 shall 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 input 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 difference of the transmitter versus time.

The moment when the 1 kHz test signal is completely suppressed is considered to provide  $t_{on}$ .

The periods of time  $t_1$  and  $t_2$  as defined in Table 2 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 input 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 Table 2 shall be used to define the appropriate template.

The result shall be recorded as frequency difference versus time.

### 8.9.3 Limits

During the periods of time  $t_1$  and  $t_3$  the frequency difference shall not exceed  $\pm 25$  kHz.

The frequency difference after the end of  $t_2$  shall be within the limit of the frequency error given in 8.1.

During the period of time  $t_2$  the frequency difference shall not exceed  $\pm 12,5$  kHz.

Before the start of  $t_3$  the frequency difference shall be within the limit of the frequency error given in 8.1.

## **8.10 Residual modulation of the transmitter**

### **8.10.1 Definition**

The residual modulation of the transmitter is the ratio, in dB, of the demodulated RF signal in the absence of wanted modulation, to the demodulated RF signal produced when the normal test modulation is applied.

### **8.10.2 Method of measurement**

The normal test modulation defined in 6.3 shall be applied to the transmitter. The high frequency signal produced by the transmitter shall be applied, via an appropriate coupling device, to a linear demodulator with a de-emphasis network of 6 dB/octave. The time constant of this de-emphasis network shall be at least 750  $\mu$ s.

Precautions shall be taken to avoid the effects of emphasizing the low audiofrequencies produced by internal noise.

The signal shall be measured at the demodulator output using an r.m.s. voltmeter.

The modulation shall then be switched off and the level of the residual audiofrequency signal at the output shall be measured again.

### **8.10.3 Limit**

The residual modulation shall not exceed –40 dB.

## **8.11 Frequency error (DSC signal)**

### **8.11.1 Definition**

The frequency error for the B-state and the Y-state is the difference between the measured frequency from the demodulator and the nominal values.

### **8.11.2 Method of measurement**

The transmitter shall be connected to the artificial antenna as specified in 6.4 and a suitable FM demodulator. The transmitter shall be set to channel 70.

The transmitter shall be set to transmit a continuous B-state or Y-state.

The measurement shall be performed by measuring the demodulated output, for both the continuous B-state and Y-state.

The measurements shall be carried out under normal test conditions (see 6.12) and extreme test conditions (see 6.13.1 and 6.13.2 applied simultaneously).

### **8.11.3 Limits**

The measured frequency from the demodulator at any time for the B-state shall be within 2 100 Hz  $\pm$  10 Hz and for the Y-state within 1 300 Hz  $\pm$  10 Hz.

## **8.12 Modulation index for DSC**

### **8.12.1 Definition**

This test measures the modulation index in the B and Y states.

### **8.12.2 Method of measurement**

The transmitter shall be set to transmit continuous B and then Y signals. The frequency deviations shall be measured.

### **8.12.3 Limits**

The modulation index shall be  $2,0 \pm 10 \%$ .

## **8.13 Modulation rate for DSC**

### **8.13.1 Definition**

The modulation rate is the bit stream speed measured in bits per second.

### **8.13.2 Method of measurement**

The transmitter shall be set to transmit continuous dot pattern.

The RF output terminal of the transmitter, via a suitable attenuator, shall be connected to a linear FM demodulator. The output of the demodulator shall be limited in bandwidth by a low pass filter with a cut-off frequency of 1 kHz and a slope of 12 dB/octave.

The frequency of the output shall be measured.

### **8.13.3 Limits**

The frequency shall be  $600 \text{ Hz} \pm 30 \times 10^{-6}$  corresponding to a modulation rate of 1 200 baud.

## **8.14 Testing of generated call sequences**

### **8.14.1 Definition**

Generated call sequences are calls which comply with the requirements of ITU-R Recommendation M.493-10.

### **8.14.2 Method of measurement**

The output of the transmitter shall be suitably connected to an apparatus for decoding and printing out the information content of the call sequences generated by the equipment.

The transmitter shall be set to transmit DSC calls as specified in annex A.

### **8.14.3 Requirement**

The requirements of ITU-R Recommendation M.493-10 regarding message composition and content shall be met.

The generated calls shall be analyzed with the calibrated apparatus for correct configuration of the signal format, including time diversity.

It shall be verified that, after transmission of a DSC call, the transmitter re-tunes to the original channel. However, in the case of a distress call, the transmitter shall tune to channel 16 and automatically select the maximum power.

The telecommands used and the channels tested for switching shall be stated in the test report.

## **9 Radiotelephone receiver**

### **9.1 Harmonic distortion and rated audiofrequency output power**

#### **9.1.1 Definition**

The harmonic distortion at the receiver output is defined as the ratio, expressed as a percentage, of the total r.m.s. voltage of all the harmonic components of the modulation audiofrequency to the total r.m.s. voltage of the signal delivered by the receiver.

The rated audiofrequency output power is the value stated by the manufacturer to be the maximum power available at the output, for which all the requirements of this standard are met.

#### **9.1.2 Methods of measurement**

Test signals at levels of +60 dB $\mu$ V (e.m.f.) and +100 dB $\mu$ V (e.m.f.), at a carrier frequency equal to the nominal frequency of the receiver and modulated by the normal test modulation (see 6.3) shall be applied in succession to the receiver input under the conditions specified in 6.1.

For each measurement, the receiver's audiofrequency volume control shall be set so as to obtain, in a resistive load which simulates the receiver's operating load, the rated audiofrequency output power (see 9.1.1). The value of this load shall be stated by the manufacturer.

Under normal test conditions (see 6.12) the test signal shall be modulated successively at 300 Hz, 500 Hz and 1 kHz with a constant modulation index of 3 (ratio between the frequency deviation and the modulation frequency). The harmonic distortion and audiofrequency output power shall be measured at all the frequencies specified above.

#### **9.1.3 Limits**

The rated audiofrequency output power shall be at least:

- 2 W in a loudspeaker;
- 1 mW in the handset earphone.

The harmonic distortion shall not exceed 10 %.

### **9.2 Audiofrequency response**

#### **9.2.1 Definition**

The audiofrequency response is defined as the variation in the receiver's audiofrequency output level as a function of the modulation frequency of the radio frequency signal with constant deviation applied to its input.



### 9.2.2 Method of measurement

A test signal of +60 dB $\mu$ V (e.m.f.), at a carrier frequency equal to the nominal frequency of the receiver and modulated with normal test modulation (see 6.3) shall be applied to the receiver antenna port under the conditions specified in 6.1.

The receiver's audiofrequency power control shall be set so as to produce a power level equal to 50 % of the rated output power (see 9.1). This setting shall remain unchanged during the test.

The frequency deviation shall then be reduced to  $\pm 1$  kHz and the audio output is the reference point in Figure 5 (1 kHz corresponds to 0 dB).

The frequency deviation shall remain constant while the modulation frequency is varied between 300 Hz and 3 kHz and the output level shall then be measured.

The measurement shall be repeated with a test signal at frequencies 1.5 kHz above and below the nominal frequency of the receiver.

### 9.2.3 Limits

The audiofrequency response shall not deviate by more than +1 dB or –3 dB from a characteristic giving the output level as a function of the audiofrequency, decreasing by 6 dB/octave and passing through the measured point at 1 kHz (see Figure 5).

## 9.3 Maximum usable sensitivity

### 9.3.1 Definition

The maximum usable sensitivity of the receiver 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 normal test modulation (see 6.3), will produce:

- in all cases, an audiofrequency output power equal to 50 % of the rated output power (see 9.1); and
- a Signal + Noise + Distortion to Noise + Distortion (SINAD) ratio of 20 dB, measured at the receiver output through a psophometric telephone filtering network such as described in ITU-T Recommendation P.53.

### 9.3.2 Method of measurement

A test signal at a carrier frequency equal to the nominal frequency of the receiver, modulated by the normal test modulation (see 6.3) shall be applied to the receiver input. An audiofrequency load and a measuring instrument for measuring SINAD ratio (through a psophometric network as specified in 9.3.1) shall be connected to the receiver output terminals.

The level of the test signal shall be adjusted until a SINAD ratio of 20 dB is obtained, using the psophometric network and with the receiver's audiofrequency power control adjusted to produce 50 % of the rated output power. Under these conditions, the level of the test signal at the input is the value of the maximum usable sensitivity.

The measurements shall be made under normal test conditions (see 6.12) and under extreme test conditions (see 6.13.1 and 6.13.2 applied simultaneously).

A receiver output power variation of  $\pm 3$  dB relative to 50 % of the rated output power may be allowed for sensitivity measurements under extreme test conditions.

### 9.3.3 Limits

The maximum usable sensitivity shall not exceed +6 dB $\mu$ V (e.m.f.) under normal test conditions and +12 dB $\mu$ V (e.m.f.) under extreme test conditions.

## 9.4 Co-channel rejection

### 9.4.1 Definition

The co-channel rejection is a measure of 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 the nominal frequency of the receiver.

### 9.4.2 Method of measurement

The two input signals shall be connected to the receiver via a combining network (see 6.1). The wanted signal shall have normal test modulation (see 6.3). The unwanted signal shall be modulated by 400 Hz with a deviation of  $\pm 3$  kHz. Both input signals shall be at the nominal frequency of the receiver under test and the measurement repeated for displacements of the unwanted signal of  $\pm 3$  kHz.

The wanted input signal shall be set to the value corresponding to the measured maximum usable sensitivity (see 9.3).

The amplitude of the unwanted input signal shall then be adjusted until the SINAD ratio (psophometrically weighted) at the output of the receiver is reduced to 14 dB.

The co-channel rejection ratio shall be expressed as the ratio in dB of the level of the unwanted signal to the level of the wanted signal at the receiver input for which the specified reduction in SINAD ratio occurs.

### 9.4.3 Limit

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

## 9.5 Adjacent channel selectivity

### 9.5.1 Definition

The adjacent channel selectivity is a measure of 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 which differs in frequency from the wanted signal by 25 kHz.

### 9.5.2 Method of measurement

The two input signals shall be applied to the receiver input via a combining network (see 6.1). The wanted signal shall be at the nominal frequency of the receiver and shall have normal test modulation (see 6.3). The unwanted signal shall be modulated by 400 Hz with a deviation of  $\pm 3$  kHz, and shall be at the frequency of the channel immediately above that of the wanted signal.

The wanted input signal level shall be set to the value corresponding to the maximum usable sensitivity. The amplitude of the unwanted input signal shall then be adjusted until the SINAD ratio at the receiver output, psophometrically weighted, is reduced to 14 dB. The measurement shall be repeated with an unwanted signal at the frequency of the channel below that of the wanted signal.

The adjacent channel selectivity shall be expressed as the lower value of the ratios in dB for the upper and lower adjacent channels of the level of the unwanted signal to the level of the wanted signal.

The measurements shall then be repeated under extreme test conditions (see 6.13.1 and 6.13.2 applied simultaneously) with the wanted signal set to the value corresponding to the maximum usable sensitivity under these conditions.

### 9.5.3 Limits

The adjacent channel selectivity shall be not less than 70 dB under normal test conditions and not less than 60 dB under extreme test conditions.

## 9.6 Spurious response rejection

### 9.6.1 Definition

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

### 9.6.2 Method of measurement

Two input signals shall be applied to the receiver input via a combining network (see 6.1). The wanted signal shall be at the nominal frequency of the receiver and shall have normal test modulation (see 6.3).

The unwanted signal shall be modulated by 400 Hz with a deviation of  $\pm 3$  kHz.

The wanted input signal level shall be set to the value corresponding to the maximum usable sensitivity. The amplitude of the unwanted input signal shall be adjusted to an e.m.f. of +86 dB $\mu$ V. The frequency shall then be swept over the frequency range from 100 kHz to 2000 MHz.

At any frequency at which a response is obtained, the input level shall be adjusted until the SINAD ratio psophometrically weighted, is reduced to 14 dB.

The spurious response rejection ratio shall be expressed as the ratio in dB between the unwanted signal and the wanted signal at the receiver input when the specified reduction in the SINAD ratio is obtained.

### 9.6.3 Limit

At any frequency separated from the nominal frequency of the receiver by more than 25 kHz, the spurious response rejection ratio shall be not less than 70 dB.

## 9.7 Intermodulation response

### 9.7.1 Definition

The intermodulation response is a measure of the capability of a 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.

### 9.7.2 Method of measurement

Three signal generators, A, B and C shall be connected to the receiver via a combining network (see 6.1). The wanted signal, represented by signal generator A shall be at the nominal frequency of the receiver and shall have normal test modulation (see 6.3). The unwanted signal from signal generator B shall be unmodulated and adjusted to the 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  $\pm 3$  kHz, and adjusted to a frequency 100 kHz above (or below) the nominal frequency of the receiver.

The wanted input signal shall be set to a value corresponding to the maximum usable sensitivity. The amplitude of the two unwanted signals shall be maintained equal and shall be adjusted until the SINAD ratio at the receiver output, psophometrically weighted, is reduced to 14 dB. The frequency of signal generator B shall be adjusted slightly to produce the maximum degradation of the SINAD ratio. The level of the two unwanted test signals shall be readjusted to restore the SINAD ratio of 14 dB. The intermodulation response ratio shall be expressed as the ratio in dB between the two unwanted signals and the wanted signal at the receiver input, when the specified reduction in the SINAD ratio is obtained.

### 9.7.3 Limit

The intermodulation response ratio shall be greater than 68 dB.

## 9.8 Blocking or desensitization

### 9.8.1 Definition

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

### 9.8.2 Method of measurement

Two input signals shall be applied to the receiver via a combining network (see 6.1). The modulated wanted signal shall be at the nominal frequency of the receiver and shall have normal test modulation (see 6.3). Initially, the unwanted signal shall be switched off and the wanted signal set to the value corresponding to the maximum usable sensitivity.

The output power of the wanted signal shall be adjusted, where possible, to 50 % of the rated output power and in the case of stepped volume controls, to the first step that provides an output power of at least 50 % of the rated output power. The unwanted signal shall be unmodulated and the frequency shall be swept between +1 MHz and +10 MHz, and also between –1 MHz and –10 MHz, relative to the nominal frequency of the receiver. The input level of the unwanted signal, at all frequencies in the specified ranges, shall be so adjusted that the unwanted signal causes:

- a) a reduction of 3 dB in the output level of the wanted signal; or
- b) a reduction to 14 dB of the SINAD ratio at the receiver output using a psophometric telephone filtering network such as described in ITU-T Recommendation P.53 whichever occurs first. This level shall be noted.

### 9.8.3 Limit

The blocking level for any frequency within the specified ranges, shall be not less than 90 dB $\mu$ V (e.m.f.), except at frequencies on which spurious responses are found (see 9.6).

## 9.9 Spurious emissions

### 9.9.1 Definition

Spurious emissions from the receiver are components at any frequency, present at the receiver input port.

The level of spurious emissions shall be measured as the power level at the antenna.

### 9.9.2 Method of measuring the power level

Spurious emissions shall be measured as the power level of any discrete signal at the input terminals of the receiver. The receiver input terminals are connected to a spectrum analyzer or selective voltmeter having an input impedance of 50  $\Omega$  and the receiver is switched on.

If the detecting device is not calibrated in terms of power input, the level of any detected components shall be determined by a substitution method using a signal generator.

The measurements shall extend over the frequency range of 9 kHz to 2 GHz.

### 9.9.3 Limit

The power of any spurious emission shall not exceed 2 nW at any frequency in the range between 9 kHz and 2 GHz.

## 9.10 Receiver residual noise level

### 9.10.1 Definition

The receiver residual noise level is defined as the ratio, in dB, of the audiofrequency power of the noise and hum resulting from spurious effects of the power supply system or from other causes, to the audiofrequency power produced by a high-frequency signal of average level, modulated by the normal test modulation and applied to the receiver input.

### 9.10.2 Method of measurement

A test signal with a level of +30 dB $\mu$ V (e.m.f.) at a carrier frequency equal to the nominal frequency of the receiver, and modulated by the normal test modulation specified in 6.3, shall be applied to the receiver input. An audiofrequency load shall be connected to the output terminals of the receiver. The audiofrequency power control shall be set so as to produce the rated output power level conforming to 9.1.

The output signal shall be measured by an r.m.s. voltmeter having a –6 dB bandwidth of at least 20 kHz. The modulation shall then be switched off and the audiofrequency output level measured again.

### 9.10.3 Limit

The receiver residual noise level shall not exceed –40 dB.

## 9.11 Squelch operation

### 9.11.1 Definition

The purpose of the squelch facility is to mute the receiver audio output signal when the level of the signal at the receiver input is less than a given value.

### 9.11.2 Method of measurement

- a) With the squelch facility switched off, a test signal of +30 dB $\mu$ V (e.m.f.), at a carrier frequency equal to the nominal frequency of the receiver and modulated by the normal test modulation specified in 6.3, shall be applied to the input terminals of the receiver. An audiofrequency load and a psophometric filtering network shall be connected to the output terminals of the receiver. The receiver's audiofrequency power control shall be set so as to produce the rated output power defined in 9.1.

The output signal shall be measured with the aid of an r.m.s. voltmeter.

The input signal shall then be suppressed, the squelch facility switched on and the audiofrequency output level measured again.

- b) With the squelch facility switched off again, a test signal modulated by the normal test modulation shall be applied to the receiver input at a level of +6 dB $\mu$ V (e.m.f.) and the receiver shall be set to produce 50 % of the rated output power.

The level of the input signal shall then be reduced and the squelch facility shall be switched on.

The input signal shall then be increased until the above-mentioned output power is reached.

The SINAD ratio and the input level shall then be measured.

- c) (Applicable only to equipment with continuously adjustable squelch control.) With the squelch facility switched off, a test signal with normal test modulation shall be applied to the receiver input at a level of +6 dB $\mu$ V (e.m.f.), and the receiver shall be adjusted to give 50 % of the rated audio output power.

The level of the input signal shall then be reduced and the squelch facility shall be switched on at its maximum position and the level of the input signal increased until the output power again is 50 % of the rated audio output power.

### 9.11.3 Limits

Under the conditions specified in 9.11.2 a), the audiofrequency output power shall not exceed –40 dB relative to the rated output power.

Under the conditions specified in 9.11.2 b), the input level shall not exceed +6 dB $\mu$ V (e.m.f.) and the SINAD ratio shall be at least 20 dB.

Under the conditions specified in 9.11.2 c), the input signal shall not exceed +6 dB $\mu$ V (e.m.f.) when the control is set at maximum.

## 9.12 Squelch hysteresis

### 9.12.1 Definition

Squelch hysteresis is the difference in dB between the receiver input signal levels at which the squelch opens and closes.

### 9.12.2 Method of measurement

If there is any squelch control on the exterior of the equipment it shall be placed in its maximum muted position. With the squelch facility switched on, an unmodulated input signal at a carrier frequency equal to the nominal frequency of the receiver shall be applied to the input of the receiver at a level sufficiently low to avoid opening the squelch. The input signal shall be increased at the level just opening the squelch. This input level shall be recorded. With the squelch still open, the level of the input signal shall be slowly decreased until the squelch mutes the receiver audio output again.

### 9.12.3 Limit

The squelch hysteresis shall be between 3 dB and 6 dB.

## 9.13 Multiple watch characteristic

### 9.13.1 Definition

The scanning period is the time between the start of two successive samples of the priority channel in the absence of a signal on that channel.

The dwell time on the priority channel is the time between the start and finish of any sample of the priority channel in the absence of a signal on that channel.

The dwell time on the additional channel is the time between the start and finish of any sample of the additional channel.

### 9.13.2 Method of measurement

The equipment shall be adjusted to scan the priority channel and one additional channel.

The squelch shall be operational and so adjusted that the receiver just mutes on both the channels.

A test signal at the carrier frequency equal to the nominal frequency of the additional channel of the receiver, modulated by the normal test modulation (see 6.3) shall be connected to the receiver via a combining network (see 6.1). A second test signal with a frequency equal to the nominal frequency of the priority channel having no modulation shall be connected to the receiver via the other input of the combining network. The level of the two test signals shall be +12 dB $\mu$ V (e.m.f.) at the receiver input.

A storage oscilloscope shall be connected to the audio output. Initially, the output of the test signal on the priority channel shall be switched off. The scanning process is started and the output observed on the oscilloscope. The gap between and the duration of the audio bursts shall be measured. Now the test signal on the priority channel shall be switched on and the scanning shall stop on the priority channel after the last burst and within the dwell time on the priority channel. The measurement shall be carried out where the additional channel is a simplex channel and repeated where it is a duplex channel.

The measurements shall be made under normal and under extreme test conditions.

### 9.13.3 Limits

The scanning period shall not exceed 2 s.

The dwell time on the priority channel shall not exceed 150 ms.

The dwell time on the additional channel shall be between 850 ms and 2 s as indicated by the time of the gap between two output bursts.

## 10 Receiver for DSC decoder

During all DSC decoder tests the equipment shall be set to scan the priority channel and the maximum number of additional channels available.

### 10.1 Maximum usable sensitivity

#### 10.1.1 Definition

The maximum usable sensitivity of the receiver 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 ratio of  $10^{-2}$ .

#### 10.1.2 Method of measurement

DSC standard test signal (see 6.8) containing DSC calls shall be applied to the receiver input. The input level shall be 0 dB $\mu$ V under normal test conditions (see 6.12) and +6 dB $\mu$ V under extreme test conditions (see 6.13.1 and 6.13.2 applied simultaneously).

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

The bit error ratio in the decoder output shall be determined as described in 6.9.



### 10.1.3 Limits

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

## 10.2 Co-channel rejection

### 10.2.1 Definition

The co-channel rejection is a measure of 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 the nominal frequency of the receiver.

### 10.2.2 Method of measurement

The two input signals shall be connected to the receiver input terminal via a combining network (see 6.1). The wanted signal shall be the DSC standard test signal (see 6.8) containing DSC calls. The level of the wanted signal shall be +3 dB $\mu$ V. The unwanted signal shall be modulated by 400 Hz with a deviation of  $\pm 3$  kHz. 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  $\pm 3$  kHz.

The input level of the unwanted signal shall be –5 dB $\mu$ V.

The bit error ratio in the decoder output shall be determined as described in 6.9.

### 10.2.3 Limits

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

## 10.3 Adjacent channel selectivity

### 10.3.1 Definition

The adjacent channel selectivity is a measure of 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 which differs in frequency from the wanted signal by 25 kHz.

### 10.3.2 Method of measurement

The two input signals shall be connected to the receiver input terminal via a combining network (see 6.1).

The wanted signal shall be the DSC standard test signal (see 6.8) containing DSC calls. The level of the wanted signal shall be +3 dB $\mu$ V under normal test conditions and +9 dB $\mu$ V under extreme test conditions.

The unwanted signal shall be modulated to 400 Hz with a deviation of  $\pm 3$  kHz. The unwanted signal shall be tuned to the centre frequency of the upper adjacent channel. The input level of the unwanted signal shall be 73 dB $\mu$ V under normal test conditions and 63 dB $\mu$ V under extreme test conditions.

The bit error ratio in the decoder output shall be determined as described in 6.9.

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

The measurement shall be carried out under normal test conditions (see 6.12) and under extreme test conditions (see 6.13.1 and 6.13.2 applied simultaneously).



### 10.3.3 Limits

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

## 10.4 Spurious response and blocking immunity

### 10.4.1 Definition

The spurious response and blocking immunity is a measure of 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 pass band of the receiver.

### 10.4.2 Method of measurement

The two input signals shall be connected to the receiver input terminal via a combining network (see 6.1).

The wanted signal shall be the DSC standard test signal (see 6.8) containing DSC calls. The level of the wanted signal shall be +3 dB $\mu$ V.

For the spurious response test, the unwanted signal shall be unmodulated. The frequency shall be varied over the range 9 kHz to 2 GHz with the exception of the channel of the wanted signal and its adjacent channels. The unwanted signal level shall be 73 dB $\mu$ V. Where spurious response occurs, the bit error ratio shall be determined.

For the blocking test, 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 unwanted signal shall be at a level of 93 dB $\mu$ V. Where blocking occurs, the bit error ratio shall be determined.

The bit error ratio in the decoder output shall be determined as described in 6.9.

### 10.4.3 Limits

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

## 10.5 Intermodulation response

### 10.5.1 Definition

The intermodulation response is a measure of 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.

### 10.5.2 Method of measurement

The three input signals shall be connected to the receiver input terminal via a combining network (see 6.1).

The wanted signal represented by signal generator A shall be at the nominal frequency of the receiver and shall be the DSC standard test signal (see 6.8) containing DSC calls. The level of the wanted signal shall be +3 dB $\mu$ V.

The unwanted signals shall be applied, both at the same level. The 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  $\pm 3$  kHz and adjusted to a frequency 100 kHz above (or below) the nominal frequency of the receiver.

The input level of the unwanted signals shall be 68 dBµV.

The bit error ratio in the decoder output shall be determined as described in 6.9.

### **10.5.3 Limits**

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

## **10.6 Dynamic range**

### **10.6.1 Definition**

The dynamic range of the equipment is the range from the minimum to the maximum level of a radio frequency input signal at which the bit error ratio in the output of the decoder does not exceed a specified value.

### **10.6.2 Method of measurement**

A test signal in accordance with the DSC standard test signal (see 6.8) containing consecutive DSC calls, shall be applied to the receiver input. The level of the test signal shall alternate between 100 dBµV and 0 dBµV.

The bit error ratio in the decoder output shall be determined as described in 6.9.

### **10.6.3 Limit**

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

## **10.7 Spurious emissions**

### **10.7.1 Definition**

Spurious emissions from the receiver are components at any frequency, present at the receiver input port.

The level of spurious emissions shall be measured as the power level at the antenna.

### **10.7.2 Method of measuring the power level**

Spurious emissions shall be measured as the power level of any discrete signal at the input terminals of the receiver. The receiver input terminals are connected to a spectrum analyzer or selective voltmeter having an input impedance of 50 Ω and the receiver is switched on.

If the detecting device is not calibrated in terms of power input, the level of any detected components shall be determined by a substitution method using a signal generator.

The measurements shall extend over the frequency range of 9 kHz to 2 GHz.

### **10.7.3 Limit**

The power of any spurious emission shall not exceed 2 nW at any frequency in the range between 9 kHz and 2 GHz.

## **10.8 Verification of correct decoding of various types of DSC calls**

### **10.8.1 Definition**

DSC call sequences are calls that comply with ITU-R Recommendation M.493-10.

### **10.8.2 Method of measurement**

The input terminal of the receiver shall be suitably connected to a calibrated apparatus for generation of digital selective call signals.

DSC calls as specified in annex A shall be applied to the receiver.

### **10.8.3 Requirement**

The requirements of ITU-R Recommendation M.493-10 regarding message composition and content shall be met.

The decoded call sequences at the output of the receiver shall be examined for correct technical format, including error-check characters.

When receiver measurements are made by use of a printer or a computer, a check shall be made to ensure accordance between printer output and display indication.

It shall be verified that the equipment is capable of switching to a channel identified in the DSC call.

The telecommands used and channels tested for switching shall be stated in the test report.

## **10.9 Reaction to VTS and AIS channel management DSC transmissions**

### **10.9.1 Definition**

VTS and AIS channel management DSC transmissions are any DSC transmissions that are in accordance with Recommendation ITU-R M.825 or M.1371.

### **10.9.2 Method of measurement**

The input terminal of the receiver shall be connected as per 10.8.2. DSC polling and regional channel management in accordance with Annex 3 of ITU-R M.1371-1 shall be applied to the receiver. A DSC transmission of format specifier symbol 112 and then with 116, category symbol 103, and otherwise similar to a distress call described in Table 4 of ITU-R M.493-10 shall also be made.

### **10.9.3 Requirement**

The equipment shall not sound an alarm, display a message (an accurate, informative display is permissible but not required), transmit a response or suggest a transmitted response, lock up, or require operator intervention.

## **10.10 Simultaneous reception**

### **10.10.1 Definition**

Simultaneous reception is the ability of the unit to correctly receive DSC traffic and radiotelephony traffic at the same time.

### **10.10.2 Method of measurement**

The radiotelephone shall be set for operation on channel 16.

Two input signals shall be connected to the receiver input terminal via combining network (see 6.1).

The radiotelephone test signal shall be at a carrier frequency equal to the nominal frequency of the receiver, modulated by the normal test modulation (see 6.3) shall be applied to the receiver input.

An audiofrequency load and a measuring instrument for measuring SINAD ratio (through a psophometric network as specified in 9.3.1) shall be connected to the receiver output terminals.

The radiotelephone test signal level shall be set for 20 dB $\mu$ V.

The SINAD shall be measured with and without the presence of the DSC test signal.

The DSC standard test signal input level shall be 0 dB $\mu$ V (see 6.8) containing DSC calls.

The bit error ratio in the decoder output shall be determined as described in 6.9.

### **10.10.3 Limits**

For radiotelephony operation the SINAD ratio shall be no less than 20 dB in the presence of the DSC test signal.

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

## **11 Electromagnetic compatibility**

### **11.1.1 Conducted spurious emission**

Conducted spurious emissions shall be determined as specified in IEC 60945 and comply to the limits contained therein.

### **11.1.2 Radiated spurious emission**

Radiated spurious emissions shall be determined as specified in IEC 60945 and comply to the limits contained therein.

### **11.1.3 Immunity to electromagnetic environment**

Tests for immunity to electromagnetic environment (conducted, radiated or transient) as applicable shall be performed as specified in IEC 60945.

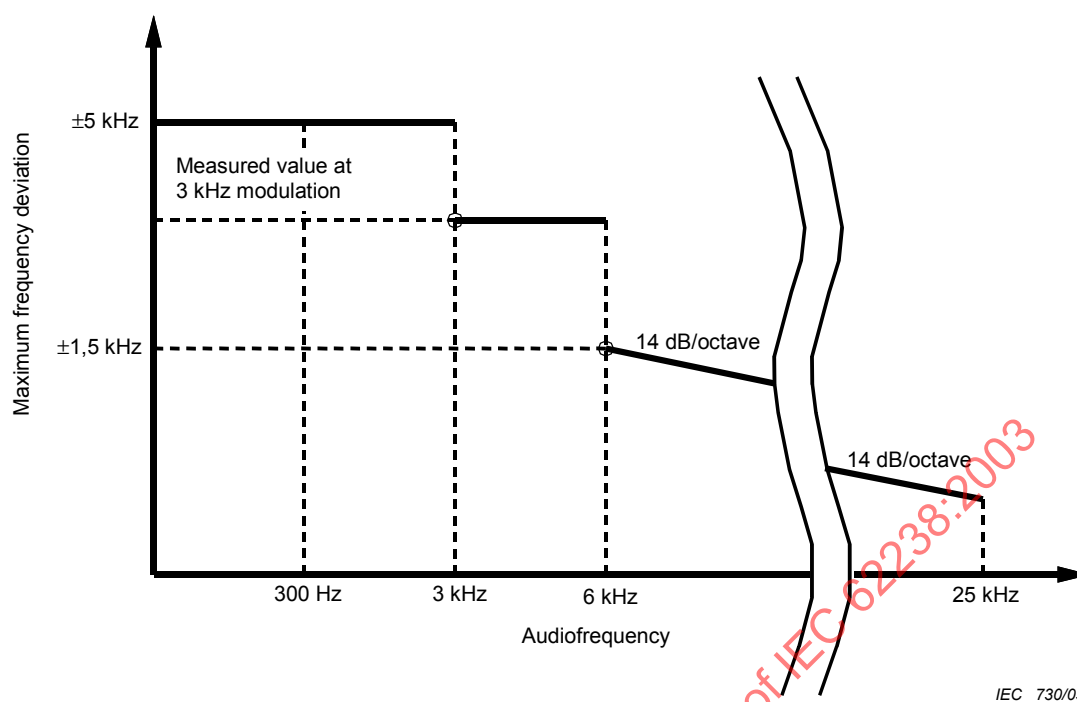


Figure 1 – Frequency deviation

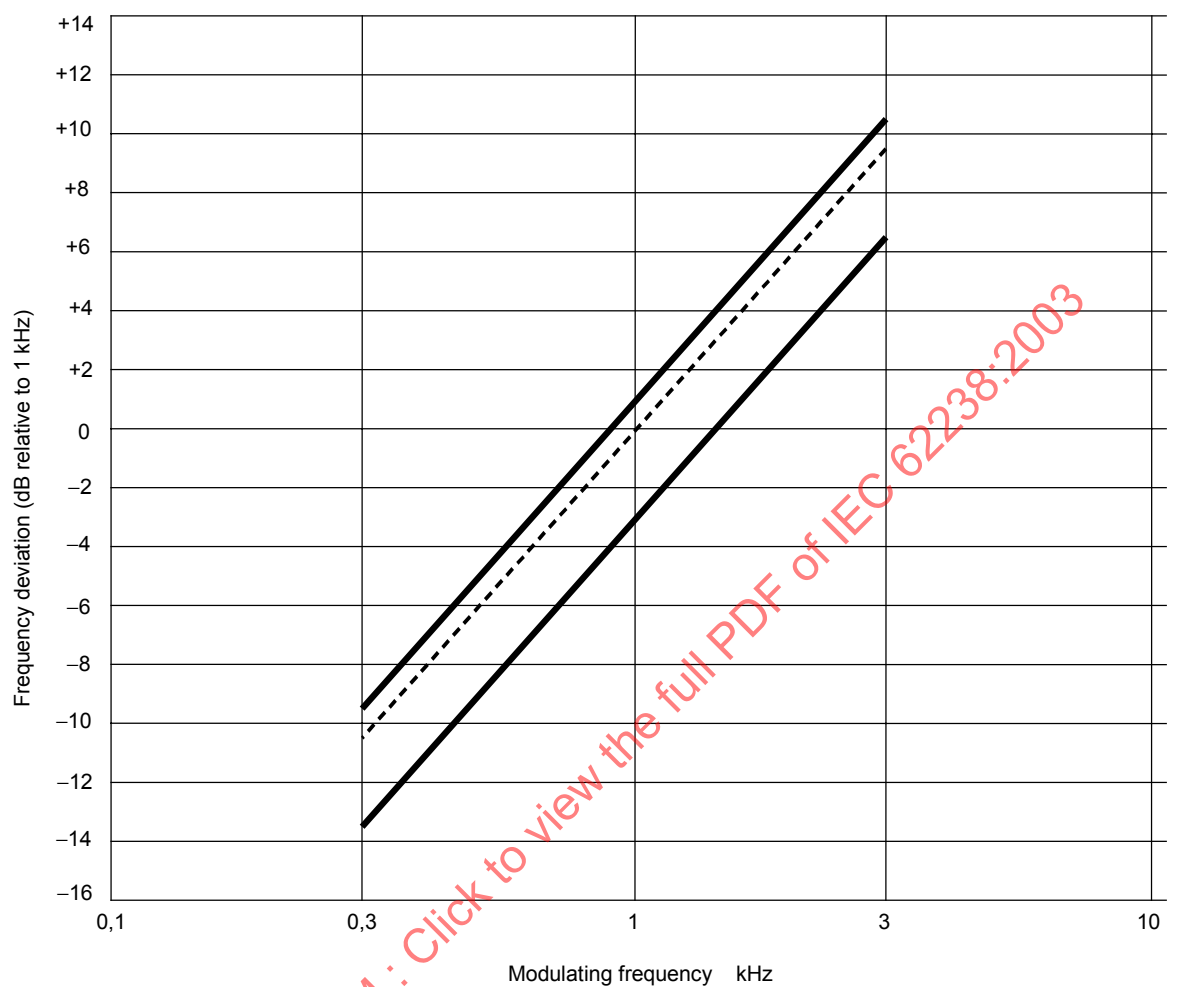
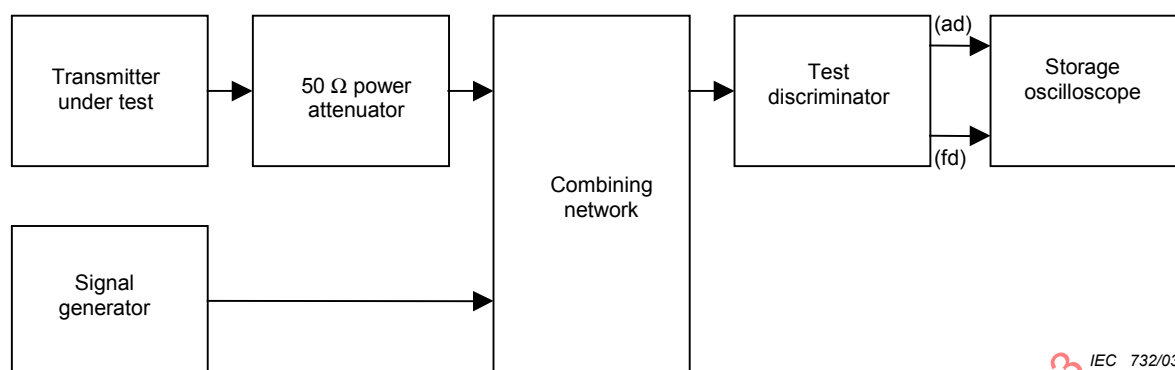
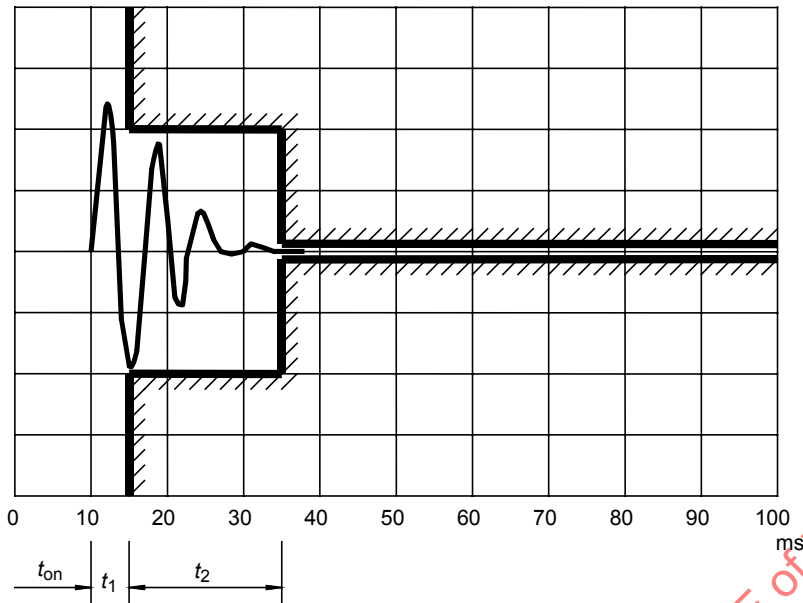


Figure 2 – Audiofrequency response



**Figure 3 – Test set-up for measuring transient frequency behaviour**

Switch-on condition  $t_{on}$ ,  $t_1$  and  $t_2$



$+\delta f = 1$  channel separation

$+\delta f = 1/2$  channel separation

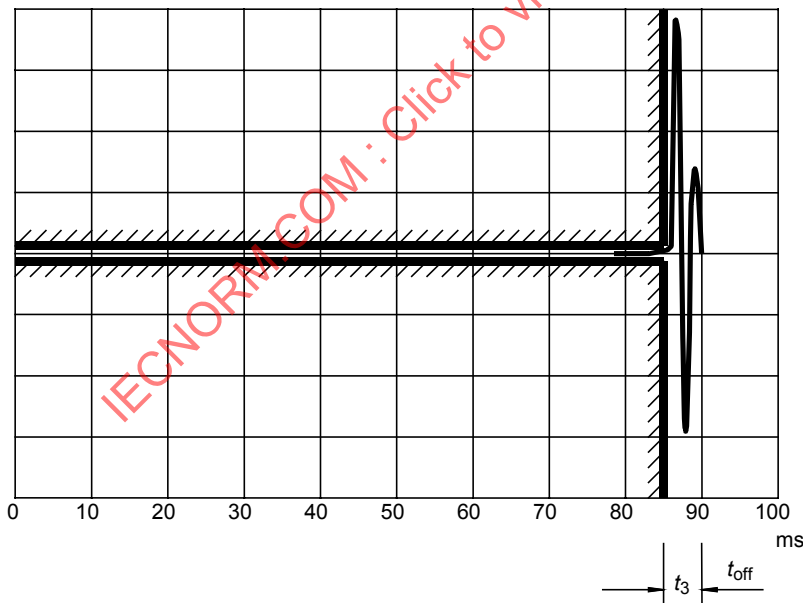
Nominal frequency

$-\delta f = 1/2$  channel separation

$-\delta f = 1$  channel separation

IEC 733/03

Switch-off condition  $t_3$ ,  $t_{off}$



$+\delta f = 1$  channel separation

$+\delta f = 1/2$  channel separation

Nominal frequency

$-\delta f = 1/2$  channel separation

$-\delta f = 1$  channel separation

IEC 734/03

Figure 4 – Storage oscilloscope view  $t_1$ ,  $t_2$  and  $t_3$



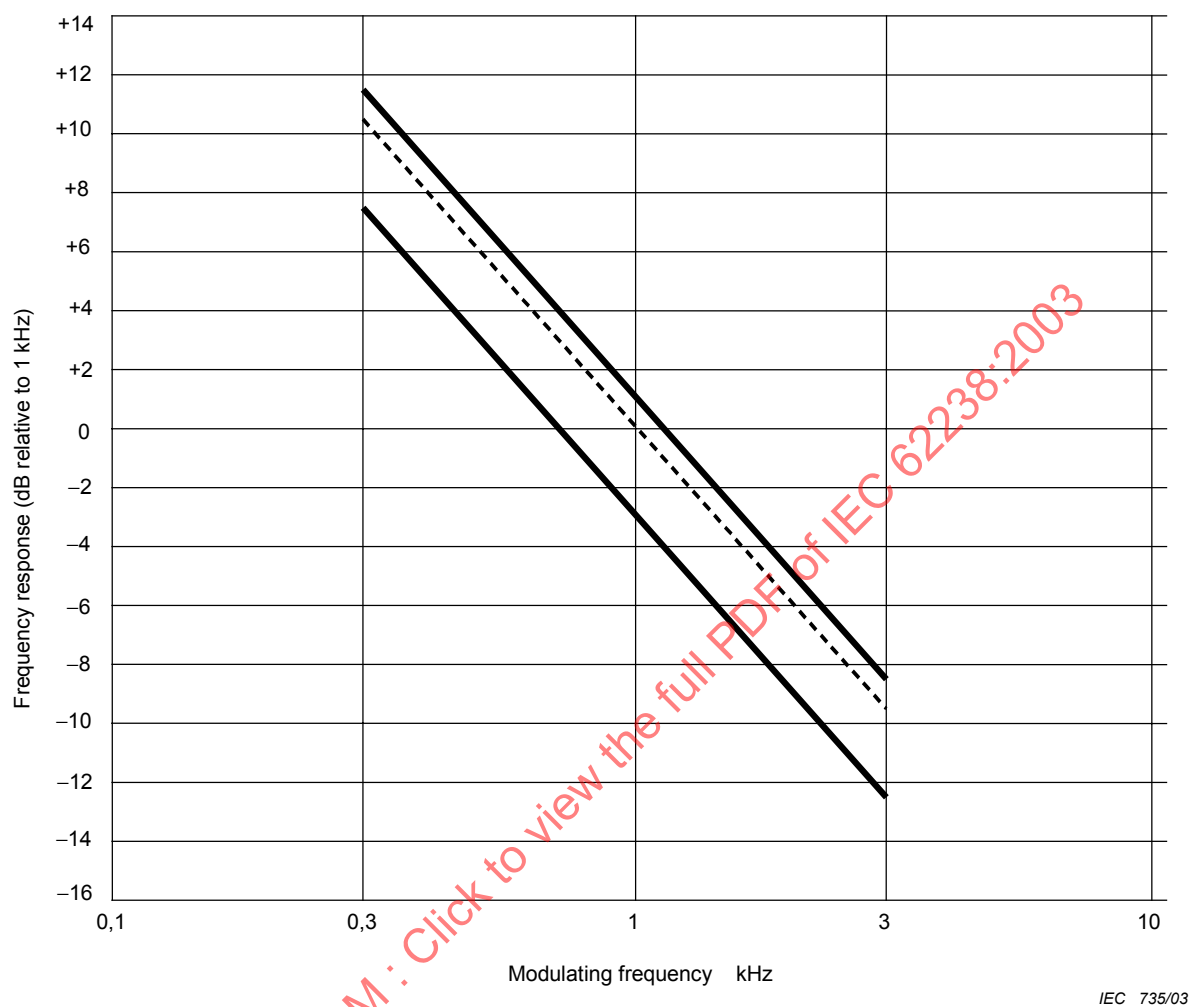


Figure 5 – Receiver audiofrequency response

## Annex A (normative)

### DSC calls

**Table A.1 – DSC calls to ITU-R Recommendation M.493**

Format specifier	Category	1st telecommand (symbol No.)	Receive	Transmit
Distress		F3E/G3E simplex (100)	X	X
All ships	Distress	Distress Ack (110)	X	
All ships	Distress	Distress Relay (112)	X	
All ships	Urgency	F3E/G3E simplex (100)	X	X
All ships	Safety	F3E/G3E simplex (100)	X	X
Individual	Urgency	F3E/G3E simplex (100)	X	
Individual	Safety	F3E/G3E simplex (100)	X	
Individual	Routine	F3E/G3E simplex (100)	X	X
Group	Routine	F3E/G3E simplex (100)	X	X
2nd telecommand Transmit and receive (126) No information				

**Table A.2 – DSC calls to ITU-R Recommendation M.821**

Expansion data specifier	Receive	Transmit
100 Enhanced position resolution	X	X

## Annex B (normative)

### Power measuring receiver specification

#### B.1 IF filter

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

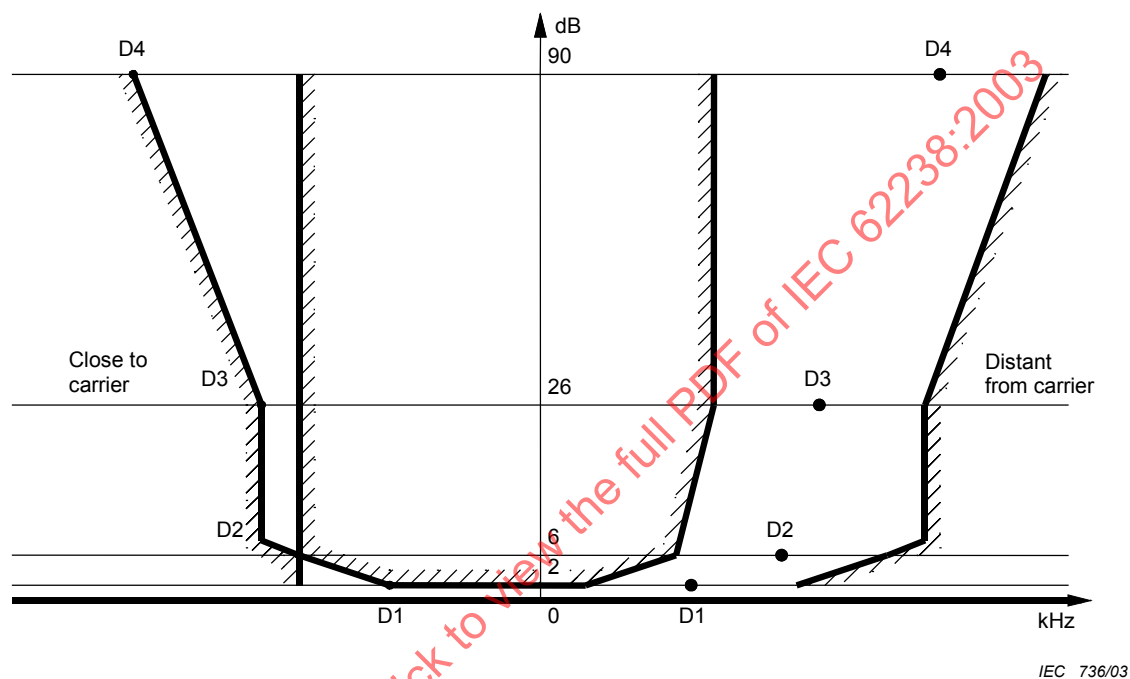


Figure B.1 – IF filter specification

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)

### **Summary of major differences of this standard from existing regional standards**

#### **C.1 European Standard EN 301 025**

EN 301 025, Electromagnetic compatibility and Radio Spectrum Matters (ERM); Technical characteristics and methods of measurement for VHF radiotelephone equipment for general communications and associated equipment for Class “D” Digital Selective Calling (DSC).

- The requirement for a dedicated channel 70 watchkeeping receiver for DSC decoder has been replaced by a channel 70 watchkeeping facility in order to permit alternative design methods. This facility, however, is still required to achieve continuous DSC monitoring (except when the transmitter is in use). A new test has been added to test that DSC reception is achieved simultaneously with radiotelephone reception.
- The requirement for a Numeric Keypad has been replaced by a more general means of easily entering a MMSI to allow more flexibility in design.
- The requirement for the transmitter to work for 30 min continuously in the high power transmit condition has been replaced by a period of 5 min to permit the use of a lower cost transmitter. Facilities have also been added to limit transmission time to 5 min.
- The requirement to protect information in volatile memories from interruptions in the power supply of up to 60 s duration has been removed as not being of practical benefit.
- A requirement to transmit and receive enhanced position information with a distress call has been added.
- EMC requirements have been added.

#### **C.2 American Standard RTCM Special Committee No 101**

RTCM recommended minimum standards for Digital Selective Calling (DSC) equipment providing minimum distress and safety capability.

- The single tuneable receiver, capable of tuning to DSC or voice channels, is acceptable but provided that continuous DSC monitoring is achieved.
- The call sequences do not include an All Ships (low power) routine call, but do include All ships Urgency and Safety calls. Routine calling to All Ships is expected to create a nuisance to SOLAS shipping. A Group call is required to enable calling amongst a group of related vessels. There is no requirement to receive a geographical area call as the minimum size area of 60 nautical miles by 60 nautical miles is not considered to be relevant to VHF operation. There is no requirement to receive a duplex call in order that equipment may be built without the expense of the duplex filter. There is also no requirement to transmit the Unable to comply telecommand and automatic acknowledgement is not required in order to avoid unnecessary traffic on channel 70.
- There is no requirement for a distinction between alarms but all alarms are required to automatically terminate after 2 min in order to limit the possible nuisance from unattended moored vessels.
- The capability to automatic switch to any channel identified in an incoming DSC call is a requirement in order to simplify operation.
- A display of DSC functions is a requirement to improve the user interface.
- A requirement to transmit and receive enhanced position information with a distress call has been added.
- Test methods, environmental and EMC requirements are included.

## Annex D (informative)

### Recommended standards for equipment operating in high level electromagnetic environments

#### D.1 Introduction

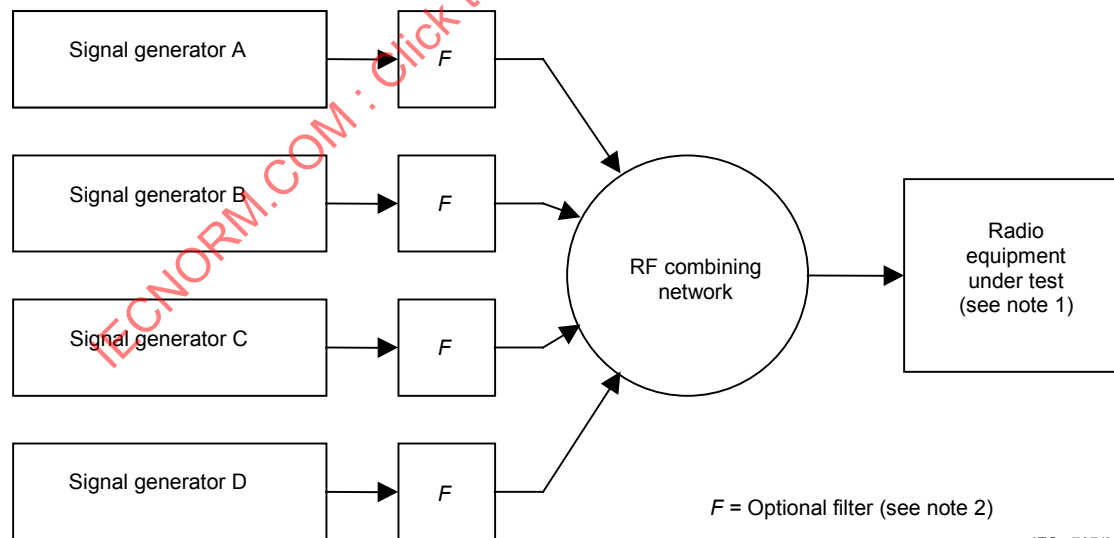
In some areas of the world, high power transmitters are located in close proximity to navigable waterways which can produce large power levels ranging from typically –40 dBm to –10 dBm. This has been observed, for instance, in the New Orleans/Baton Rouge waterway areas in the USA. Such power levels generate in-band nonlinear reactions, such as desensitization or intermodulation in the receiver input of greater severity than those anticipated by the blocking and intermodulation tests of this standard.

Equipment intended for use in such areas is recommended to meet the requirements of the test below. Receivers meeting the requirements below should be capable of useful reception in such environments better than 95 % of the time.

Optional circuitry accessible by operator, for example a switched RF attenuator, may be used to meet the limits required by the test.

#### D.2 Method of measurement

Four signal generators A, B, C, and D shall be connected to the receiver via a combining network as indicated in Figure D.1. Signal levels specified are measured at the RF input of the radio under test.



IEC 737/03

NOTE 1 Optional circuitry accessible by operator, for example a switched RF attenuator, may be used to meet this standard.

NOTE 2 Optional filters can be used to improve the spectral purity of the generated signals.

**Figure D.1 – Method of measurement**