



BSI Standards Publication

Global maritime distress and safety system (GMDSS)

Part 7: Shipborne VHF radiotelephone transmitter and receiver — Operational and performance requirements, test methods and required test results

National foreword

This British Standard is the UK implementation of IEC 61097-7:2025.

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A list of organizations represented on this committee can be obtained on request to its committee manager.

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INTERNATIONAL STANDARD

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



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

GLOBAL MARITIME DISTRESS AND SAFETY SYSTEM (GMDSS) –**Part 7: Shipborne VHF radiotelephone transmitter and receiver –
Operational and performance requirements,
test methods and required test results**

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IEC 61097-7 has been prepared by IEC technical committee 80: Maritime navigation and radiocommunication equipment and systems. It is an International Standard.

This second edition cancels and replaces the first edition published in 1996, and Amendment 1:2018. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) the text has been updated to incorporate the provisions of the new IMO performance standards given in Resolution MSC.511(105) and new ITU-R recommendations given in M.493-16;

- b) the provisions for digital selective calling which were previously in IEC 61097-3 have been incorporated;
- c) the provisions for watch keeping receivers which were previously in IEC 61097-8 have been incorporated;
- d) new requirements have been added for a received signal strength indicator in 4.3.4 and for software maintenance in 4.6 in support of IMO recommendations;
- e) new Annex B and Annex E have been added for bridge alert management;
- f) new Annex C and Annex D have been added for digital selective calling;
- g) a new Annex F has been added for remote control operation;
- h) a new Annex G has been added for equipment manuals.

The text of this International Standard is based on the following documents:

Draft	Report on voting
80/1151/FDIS	80/1157/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

A list of all parts in the IEC 61097 series, published under the general title *Global maritime distress and safety system (GMDSS)*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

GLOBAL MARITIME DISTRESS AND SAFETY SYSTEM (GMDSS) –

Part 7: Shipborne VHF radiotelephone transmitter and receiver – Operational and performance requirements, test methods and required test results

1 Scope

This part of IEC 61097 specifies the minimum performance requirements, technical characteristics and test methods with required test results for VHF radio installations capable of voice communication and digital selective calling as required by chapter IV of the International Convention for Safety of Life at Sea (SOLAS).

This document incorporates the applicable part of the performance standards included in IMO Resolution A.524(13) and MSC.511(105), the technical characteristics included in Recommendation ITU-R M.489-2 and Recommendation ITU-R M.493-16, and takes account of IMO Resolution A.694(17) which is associated with IEC 60945, and conforms with the ITU Radio Regulations where applicable.

When a requirement in this document is different from IEC 60945, the requirement in this document shall take precedence.

This document also takes account, as appropriate, of requirements for the presentation of navigation-related information on shipborne navigational displays given in IMO Resolution MSC.191(79) and is associated with IEC 62288 and the requirements for bridge alert management given in Resolution MSC.302(87) associated with IEC 62923-1 and IEC 62923-2.

NOTE 1 All text of this document, whose wording is identical to that in IMO Resolutions and ITU-R Recommendations is printed in *italics* and the Resolution/Recommendation and clause numbers are indicated in brackets.

NOTE 2 This document introduces requirements, tests and their required results in the context of digital selective calling (DSC) as defined by ITU-R recommendations such as ITU-R M.493, and in the context of bridge alert management (BAM) as defined by IMO MSC.302(87) and IEC 62923-1. Certain terms, such as "alert", "warning" and "priority" can have different meanings depending on the context in which the term is used. The meaning of specific terms used in this document is as defined in the context of DSC unless specifically expressed otherwise. For example, the expression "BAM alert" is used to indicate that the term "alert" is used in the context of BAM in that instance. Annex E provides further specifications on mapping of signals between the context of DSC and the context of BAM.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 61108 (all parts), *Maritime navigation and radiocommunication equipment and systems – Global navigation satellite systems (GNSS)*

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

IEC 61162-2, *Maritime navigation and radiocommunication equipment and systems – Digital interfaces – Part 2: Single talker and multiple listeners, high-speed transmission*

IEC 61162-450, *Maritime navigation and radiocommunication equipment and systems – Digital interfaces – Part 450: Multiple talkers and multiple listeners – Ethernet interconnection*

IEC 62288, *Maritime navigation and radiocommunication equipment and systems – Presentation of navigation-related information on shipborne navigational displays – General requirements, methods of testing and required test results*

IEC 62923-1, *Maritime navigation and radiocommunication equipment and systems – Bridge alert management – Part 1: Operational and performance requirements, methods of testing and required test results*

ITU Radio Regulations:2024, Appendix 3: *Maximum permitted power levels for unwanted emissions in the spurious domain*

ITU Radio Regulations:2024, Appendix 18: *Table of transmitting frequencies in the VHF maritime mobile band*

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

ITU-R M.493-16:2023, *Digital selective-calling system for the use in the maritime mobile service*

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

3 Terms, definitions and abbreviated terms

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1 Terms and definitions

3.1.1

acknowledged

indication that the objective of the initial DSC call has been achieved when used to describe an automated procedure

3.1.2

active

automated procedure which has control of the general receiver and transmitter and is thus able to engage in subsequent communications and receive DSC calls on both the watch receiver and general receiver

3.1.3**audible indication**

brief self-terminating sound which is repeated once every 30 s until confirmation or self-terminating after 5 min indicating the reception of a DSC call of a category other than distress or urgency or a repetition of a call of categories distress or urgency already received

Note 1 to entry: The purpose of this alert is to inform the operator that a DSC call is received but it does not require immediate attention.

3.1.4**automated procedure**

set of actions necessary to complete the objective of an initiating DSC call or non-DSC communication event

3.1.5**BAM alert**

alert defined by the concept of bridge alert management (BAM)

3.1.6**critical errors**

set of information characters obtained from one or more received DSC calls if the automated procedure needs information characters from that set in order to proceed or perform any task, but the required information characters are in error

EXAMPLE An acknowledgement cannot be composed to an individual DSC call that has errors in the sender's MMSI.

3.1.7**default**

value selected or action taken by the equipment software in the absence of any operator input

3.1.8**distress alert**

single distress DSC call with the format specifier symbol 112 as defined in ITU-R Recommendation M.493

3.1.9**distress alert attempt**

set of distress alerts sent by a vessel when in distress

3.1.10**distress DSC message**

DSC message or acknowledgement containing the distress information

3.1.11**distress event**

unique distress situation identified by two parameters of the distress information

Note 1 to entry: The parameters are the MMSI of the vessel in distress and the nature of distress.

3.1.12**distress information**

symbols within a DSC call describing a distress situation consisting of the MMSI of the vessel in distress, the nature of distress, the position of the vessel in distress, the UTC time of that position

3.1.13**DSC word**

10 bits that make up the coded entities of a transmitted DSC message

Note 1 to entry: The 10 bits consist of a seven bit "symbol" that gives the information content and a three-bit zero count for the purposes of error testing.

3.1.14**Dx and Rx**

notation used to describe the time diversity structure of DSC calls

3.1.15**engaged**

indication that the equipment is busy handling an automated procedure

3.1.16**factory default**

default value that is set by the manufacturer such that the field or behaviour is defined prior to any operator intervention

3.1.17**general receiver**

receiver used for the reception of all subsequent communications

3.1.18**identical**

set of information characters where all pairs of corresponding information characters are equal or, if a pair of corresponding information characters is not equal, one of the pair is in error

3.1.19**information characters**

set of symbols in a DSC call that contains the items of interest for the recipient and is used to compute the ECC symbol that terminates the message

3.1.20**non-distress DSC message**

DSC message or acknowledgment that does not contain the distress information

3.1.21**on hold**

automated procedure which does not have access to the transmitter and general receiver and therefore cannot engage in subsequent communications and is only able to receive DSC messages on the watch receiver

3.1.22**operator options**

any choices the operator can make while the automated procedure is engaged

3.1.23**parallel event handling**

background process of handling a received DSC message that is not pertinent to the active automated procedure

3.1.24**pertinent to the station**

any DSC message that would start an automated procedure if the equipment were in standby

3.1.25

snooping

situation where a station receives and handles DSC messages pertinent to other stations as if it were that station

3.1.26

standby

status used to indicate that the equipment is not handling an automated procedure, either active or on hold, but being able to receive DSC calls

3.1.27

symbol

seven bits of a 10 bit DSC word that have the information content

3.1.28

top level

items, buttons, or functions present and visible without requiring any action by the operator (such as scrolling, opening up menus, or removing any obscuring covers)

3.1.29

watch receiver

separate receiver that continuously monitors the DSC frequency channel 70

3.2 Abbreviated terms

BAM	bridge alert management
BNWAS	bridge navigational watch alarm system
CAM	central alert management
CCRS	consistent common reference system
Comms	communication
DB	distress button
DROBOSE	distress relay on behalf of someone else
DSC	digital selective calling
e.m.f.	electromotive force
ECC	error check character
EPFS	electronic position fixing system
EUT	equipment under test
INS	integrated navigation system
MOB	man overboard
MMSI	maritime mobile service identity
p.t.t.	press-to-transmit
RF	radio frequency
RMS	root mean square
SINAD	ratio of signal + noise + distortion power to noise + distortion power
SWR	standing wave ratio
TE	test equipment

4 Performance requirements

(See 8.1.5)

4.1 General

(MSC.511(105)/A1.2) *The VHF radio installation, in addition to meeting the requirements of the Radio Regulations, the relevant ITU-R Recommendations and the general requirements set out in resolutions A.694(17) and MSC.191(79), as amended, shall comply with the following performance standards.*

(MSC.511(105)/A2.1) *The installation, which may consist of more than one piece of equipment, shall be capable of operating on single-frequency channels or on single- and two-frequency channels.*

(MSC.511(105)/A2.2) *The equipment shall provide for the following categories of calls using both voice and digital selective calling (DSC):*

- .1 distress, urgency and safety;*
- .2 ship operational requirements; and*
- .3 general radiocommunications.*

(MSC.511(105)/A2.3) *The equipment shall provide for the following categories of communication using voice:*

- .1 distress, urgency and safety;*
- .2 ship operational requirements; and*
- .3 general radiocommunications*

(MSC.511(105)/A2.4) *The equipment shall comprise at least:*

- .1 a transmitter/receiver including antenna;*
- .2 an integral control unit or one or more separate control units;*
- .3 a microphone with a press-to-transmit switch, which may be combined with a telephone in a handset;*
- .4 an internal or external loudspeaker;*
- .5 an integral or separate digital selective calling facility; and*
- .6 a dedicated DSC watchkeeping facility to maintain a continuous watch on channel 70.*

(MSC.511(105)/A2.5) *The installation may also include additional receivers.*

Unless otherwise stated in this document, the equipment shall comply with the requirements of the environmental and electromagnetic conditions specified in IEC 60945.

4.2 Power supply

(MSC.511(105)/A3) *The VHF radio installation shall be powered from the ship's main source of electrical energy. In addition, it shall be possible to operate the VHF installation from an alternative source of electrical energy.*

4.3 Controls and indicators

4.3.1 General

(MSC.511(105)/A4.1) *Control of the equipment shall be possible at the position from which the ship is normally navigated. Control from that position shall have priority if additional control units are provided. When there is more than one control unit, indication shall be given to the other units that the equipment is in operation.*

(MSC.511(105)/A4.2) *The equipment shall provide a standard interface to enable the selections of channels and setting of Maritime Mobile Service Identity (MMSI) to be called from a remote control unit (e.g. INS) by using standardized interfaces (see 4.4). Requirements on remote operation are specified in Annex F.*

4.3.2 DSC controls and indicators

(MSC.511(105)/A4.3.1) *It shall be possible to initiate and make distress and safety calls from the position from which the ship is normally navigated. The means for initiating a distress call shall be as prescribed in 4.3.3.*

(MSC.511(105)/A4.3.4) *Means shall be provided to enable routine testing of the DSC facilities without radiation of signals.*

(MSC.511(105)/A4.3.5) *Provision shall be made for:*

- .1 specific alerts to indicate receipt of a distress or urgency calls or a call having distress category. It shall not be possible to disable this alarm and indication. Provision shall be made to ensure that they can be reset only manually; and*
- .2 alerts for calls other than distress and urgency.*

The user manual shall include instructions for routine testing for the DSC.

4.3.3 Distress controls

(MSC.511(105)/A2.6) *A distress alert shall be activated only by means of a dedicated distress button. This button shall not be any key of an ITU-T digital input panel or an ISO keyboard associated with the equipment and shall be physically separated from functional buttons/keys used for normal operation. This button shall be a single button for no other purpose than to initiate a distress alert.*

(MSC.511(105)/A2.7) *The dedicated distress button shall:*

- .1 be clearly identified and be red in colour and marked "DISTRESS". Where a non-transparent protective lid or cover is used, it shall also be marked "DISTRESS"; and*
- .2 be protected against inadvertent operation. The required protection of the distress button shall consist of 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 additional 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. The distress button shall initiate a distress alert when kept pressed for at least three seconds. A flashing light and an intermittent acoustic signal shall start immediately. After the three seconds, the transmission of the distress alert is initiated and the indication shall become steady and the acoustic signal shall stop. If the distress button is released before a distress alert is initiated, the light shall go out and the acoustic signal shall stop.

(MSC.511(105)/A2.8) *The distress alert initiation shall require at least two independent actions. The lifting of the protective lid or cover is considered as the first action. Pressing the distress button as specified above is considered as the second independent action.*

(MSC.511(105)/A2.9) *The equipment shall indicate the status of the distress alert transmission.*

(MSC.511(105)/A2.10) *It shall be possible to interrupt and initiate distress alerts at any time and to interrupt repetitive transmissions of distress messages. Such operation shall not interrupt the transmission of a distress alert or distress message in progress but shall prevent repetitive transmissions of a distress message.*

4.3.4 Received signal strength indicator

The equipment shall provide a received signal strength indicator (RSSI), which can be observed by the operator. The user manual shall describe means to access and interpret the RSSI.

NOTE The purpose of the RSSI is to provide means for the mariner to detect the presence of interference to the VHF radiotelephone on the channel selected for reception. The assumed method for the mariner to detect interference is to select a free channel and observe that the RSSI level does not change when suspected interfering devices are activated and deactivated. The style of indication can for example be a relative bar-graph or absolute indication with a suitable averaging filter implemented to allow the mariner to observe the relative growth of the received signal as a result of actions controlled by the mariner.

4.3.5 Markings and identifications

Markings and identifications shall be in accordance with IEC 60945.

4.4 Interfaces and human-machine interface

(MSC.511(105)/A5.1) *Where the equipment is part of an integrated communication system (ICS), integrated navigation system (INS), integrated bridge system (IBS) or connected to a navigation system, this shall not impair any of the GMDSS functions of the system or the equipment itself.*

(MSC.511(105)/A5.2) *Equipment shall provide an interface for bridge alert management (BAM) in accordance with resolution MSC.302(87) on Performance standards for bridge alert management.*

(MSC.511(105)/A5.3) *The equipment shall provide an interface to report a ship identifier and location data from a received distress alert, maritime safety information (MSI) or search and rescue (SAR) related information to navigation display system in order to enable a graphical display and possible linking to available target information.*

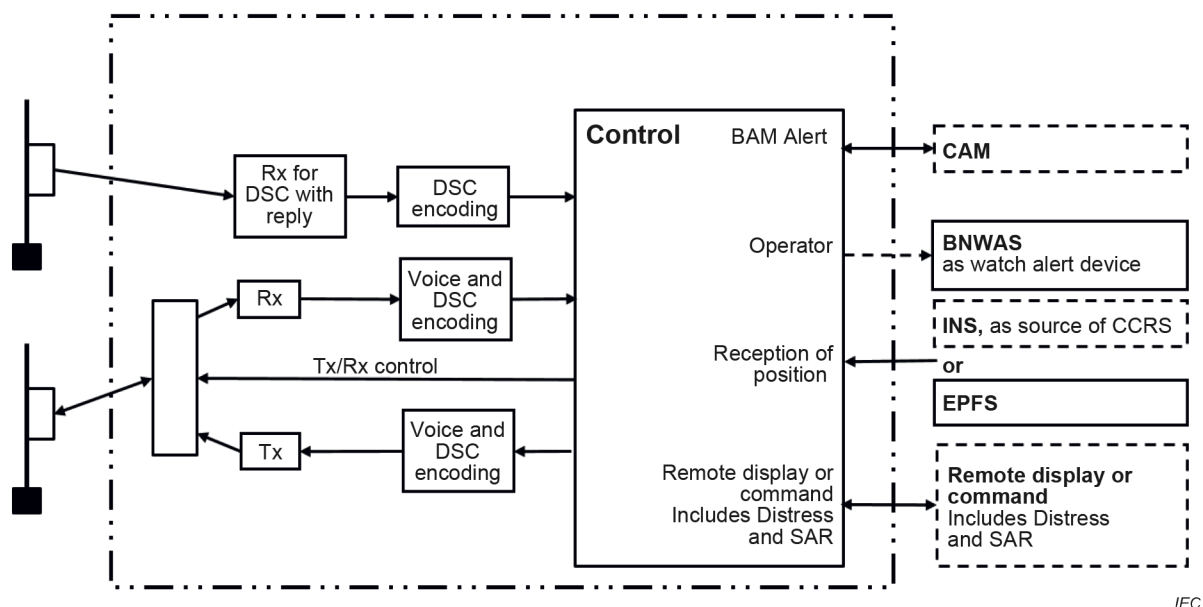
(MSC.511(105)/A5.4) *All interfaces provided for communication with other navigation and communication equipment shall comply with the relevant international standards.*

(MSC.511(105)/A6.1) *The human-machine interface (HMI) shall provide all functions necessary to carry out all communication procedures including those required by the GMDSS.*

(MSC.511(105)/A6.2) *Visual indications and visual presentations of text and graphics of the system shall conform to resolution MSC.191(79), as amended as specified in IEC 62288.*

Data interfaces shall be compatible with at least one of the interfaces given in IEC 61162-1, IEC 61162-2 or IEC 61162-450. The manufacturer shall specify which alternative of IEC 61162 each physical interface supports.

Logical interfaces are shown in Figure 1. The manufacturer shall specify if any of the provided logical interfaces share the same physical interface.



NOTE Solid line indicates mandatory part.

Figure 1 – Interfaces of the equipment

As a minimum, the sentences GLL, GGA, RMC and GNS shall be recognised for input of position information. See Table 1.

Additionally, for remote display and/or command purposes, the equipment shall be capable of outputting sentences DSC and DSE and inputting the sentence DSC (see Table 2 and Table 3).

Optionally, if provided, the equipment may include an interface to report operator activity in order that the BNWAS can reset the dormant period (see Table 4). The EVE sentence as specified in IEC 61162-1 shall be output in response to user-interaction with the DSC under conditions described in the user manual.

Sentences used by the BAM interface are listed in Table 5 and Table 6.

No connection of, or failure within any connected equipment shall affect the required performance of the equipment covered by this document.

Table 1 – Sentences input to the equipment for position information

Mnemonic	Interface (see Figure 1)	Name	Comment
GLL GGA GNS ^a RMC ^a	INS, as source of CCRS or EPFS	Geographic position – latitude/longitude	
^a refer to IEC 61108-7:2024			

Table 2 – Sentences output from the equipment

Mnemonic	Interface (see Figure 1)	Name	Comment
DSC DSE	Remote display or command	Digital selective calling information	Report a received DSC distress call detail information

Table 3 – Sentences input to the equipment

Mnemonic	Interface (see Figure 1)	Name	Comment
DSC	Remote display or command	Digital selective calling information	Specifies details of a DSC call initiation

Table 4 – Sentences output from the equipment for BNWAS

Mnemonic	Interface (see Figure 1)	Name	Comment
EVE	BNWAS, as watch alert device	Operator activity	Reset dormant period of the BNWAS

Table 5 – Sentences output from the equipment for CAM

Mnemonic	Interface (see Figure 1)	Name	Comment
ALC	CAM	Cyclic BAM alert list	List of current BAM alerts
ALF	CAM	BAM Alert sentence	Details of a new BAM alert
ARC	CAM	BAM Alert command refused	BAM Alert command not accepted

Table 6 – Sentences input to the equipment from CAM

Mnemonic	Interface (see Figure 1)	Name	Comment
ACN	CAM	BAM Alert command	BAM Alert command e.g. acknowledge
HBT	CAM	Heartbeat	Supports reliable alert related communication

The talker identifier for VHF equipment shall be CV.

4.5 Bridge alert management

The equipment shall implement BAM functionality compliant to IMO MSC.302(87) and IEC 62923. The equipment shall fulfil the requirements applicable for BAM function type P as described in IEC 62923-1. Further requirements specific to BAM are described in Annex B.

4.6 Manuals

In addition to the requirements of IEC 60945, the manufacturer shall make the declarations and provide information in the user/installation manual as specified in Annex G.

4.7 Software maintenance

Means shall be provided to enable software used by the radio, including software controlling the selection of radio frequency channels, to be updated by manufacturer-controlled means.

NOTE IEC 61162-460 and IEC 63154 contain guidance on cyber security for maritime navigation and radiocommunication equipment.

It shall be possible for the user to view the software versions in use.

5 Transmitter

5.1 Frequencies and classes of emission

5.1.1 General

(See 8.1.5)

(MSC.511(105)/B1.1) *The equipment shall be designated for operation on channels selected from and in accordance with appendix 18 to the Radio Regulations.*

(MSC.511(105)/B1.2) *The radiotelephone facility shall be capable of operating as follows:*

- .1 in the band 156,025 MHz to 157,425 MHz on single-frequency channels as specified in appendix 18 to the Radio Regulations; and*
- .2 in the band 156,025 MHz to 157,325 MHz for transmitting and the band 160,625 MHz to 161,925 MHz for receiving on two-frequency channels as specified in appendix 18 to the Radio Regulations.*

(MSC.511(105)/B1.3) *The digital selective calling facility shall be capable of operating on channel 70.*

(MSC.511(105)/B1.4) *Class of emission shall comply with chapter IX of the Radio Regulations.*

(ITU-R M.489-2/1.1.1 and .3) *The class of emission shall be G3E (frequency modulation with a pre-emphasis characteristic of 6 dB/octave) for voice communication. It shall be phase modulation G2B for DSC signalling.*

(ITU-R M.489-2/1.1.2) *The necessary bandwidth shall be 16 kHz.*

5.1.2 Frequency deviation

(See 8.3.4, 8.3.5, 8.3.6, 8.3.11)

(ITU-R M.489-2/1.1.4) *The frequency deviation corresponding to 100 % modulation shall approach ± 5 kHz as nearly as practicable. In no event shall the frequency deviation exceed ± 5 kHz. Deviation limiting circuits shall be employed such that the maximum frequency deviation shall be independent of the input audiofrequency.*

5.1.3 Audiofrequency band

(See 8.3.4, 8.3.7, 8.3.8)

(ITU-R M.489-2/1.2.5) *The upper limit of the audiofrequency band shall not exceed 3 kHz.*

5.2 Frequency accuracy and tolerance

(See 8.3.2, 8.3.12)

(MSC.511(105)/B2) *The frequency tolerance for ship station transmitters shall not exceed 10 parts in 10^6 .*

NOTE The frequency tolerance for coast station transmitters does not exceed 5 parts in 10^6 .

5.3 Output power

(See 8.3.3, 8.3.9, 8.3.10)

(MSC.511(105)/B3.1) *The transmitter output power shall be between 6 W and 25 W.*

(MSC.511(105)/B3.2) *Provision shall be made for reducing the transmitter output power to a value of less than 1 W. However, this reduction of the power is optional on channel 70.*

(ITU-R M.489-2/1.2.2) *Spurious emissions on discrete frequencies, when measured in a non-reactive load equal to the nominal output impedance of the transmitter, shall be in accordance with the provisions of Appendix 3 of the Radio Regulations.*

5.4 Permissible warming-up period

(See 8.3.2)

(MSC.511(105)/B4) *The equipment shall be operational within five seconds after switching on.*

5.5 Continuous operation

(See 8.3.3)

(MSC.511(105)/B5) *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 transmission time to a maximum of five minutes shall be provided.*

5.6 Controls and indicators

5.6.1 Channel control and switching

5.6.1.1 Channel switching

(See 8.3.1)

(MSC.511(105)/B6.1.1) *Change of channel shall be capable of being made as rapidly as possible, but in any event within five seconds.*

(MSC.511(105)/B6.1.2) *The time taken to switch from the transmit to the receive condition, and vice versa, shall not exceed 0,3 seconds.*

5.6.1.2 Channel control

(See 8.1.5)

(MSC.511(105)/B6.1.3) *An on/off switch shall be provided for the entire installation with a visual indication that the installation is switched on.*

(MSC.511(105)/B6.1.4) *A visual indication that the carrier is being transmitted shall be provided.*

(MSC.511(105)/B6.1.5) *The equipment shall indicate the four-digit channel number, as given in the Radio Regulations Appendix 18, to which it is tuned. It shall allow the determination of the channel number under all conditions of external lighting. Where practicable, channels 16 and 70 should be distinctively marked.*

If the radio is capable of displaying channel designators in other than the channel numbers described by Appendix 18 of the ITU Radio Regulations, then the default setting shall be to display channel numbers using the scheme specified by Appendix 18 of the ITU Radio Regulations.

NOTE Some administrations require ships operating in their waters to be capable of communicating on channels not addressed in the table described by ITU Radio Regulations 2024, Appendix 18 NOTE B. Some administrations prohibit specific channels being used.

(MSC.511(105)/B6.1.6) *The equipment shall not be able to transmit during a channel switching operation.*

(MSC.511(105)/B6.1.7) *Operation of the transmit/receive control shall not cause unwanted emissions.*

5.6.2 Radiotelephone facility

5.6.2.1 Controls

(See 8.1.5)

(MSC.511(105)/B6.2.1) *Provision shall be made for changing from transmission to reception by use of a press-to-transmit switch. Additionally, facilities for operation on two-frequency channels without manual control may be provided.*

(MSC.511(105)/B6.2.2) *The receiver shall be provided with a manual volume control by which the audio output may be varied.*

5.6.2.2 Squelch

(See 8.4.12, 8.4.13)

(MSC.511(105)/B6.2.3) *A squelch (mute) control shall be provided on the exterior of the equipment.*

5.6.3 Loudspeaker and telephone handset (radiotelephone facility)

(See 8.1.5)

(MSC.511(105)/B6.3.1) *The receiver output shall be suitable for use with a loudspeaker and a telephone handset. The audio output shall be sufficient to be heard in the ambient noise level likely to be encountered on board ships.*

(MSC.511(105)/B6.3.2) *It shall be possible to switch off the loudspeaker without affecting the audio output of the telephone handset, if provided.*

(MSC.511(105)/B6.3.3) *In the transmit condition during simplex operation, the output of the receiver shall be muted.*

(MSC.511(105)/B6.3.4) *In the transmit condition during duplex operation, only the telephone handset shall be in circuit. Care shall be taken to prevent any electrical or acoustic feedback, which could cause singing.*

5.7 Safety precautions

(See 8.3.13)

(MSC.511(105)/B7.1) *The equipment, when operating, shall not be damaged by the effects of open-circuited or short-circuited antenna terminals.*

(MSC.511(105)/B7.2) *In case the standing wave ratio (SWR) becomes too high the power of the transmitter shall be automatically reduced without stopping the transmission and an appropriate alert shall be initiated.*

5.8 Antenna system

(See 8.1.5)

(MSC.511(105)/B8) *The VHF antenna or antennae shall be vertically polarized and, as far as practicable, be omnidirectional in the horizontal plane. The installation shall be suitable for efficient radiation and reception of signals at the operating frequencies.*

6 Receiver

6.1 Frequencies and classes of emission

(See 8.4.9)

(MSC.511(105)/C1) See 5.1.

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

6.2 Frequency tolerance and accuracy

(MSC.511(105)/C2) *The frequency tolerance for ship station receivers shall not exceed 10 parts in 10^6 . See 5.2.*

6.3 Usable sensitivity

6.3.1 Radiotelephone facility

(See 8.4.3)

(MSC.511(105)/C3.1) *The sensitivity of the receiver shall be equal to or better than 2 μ V e.m.f. for a signal-to-noise and distortion (SINAD) ratio of 20 dB.*

6.3.2 Digital selective calling facility

(See 8.5)

(MSC.511(105)/C3.2) *With a DSC modulated input signal having a level of 1 μ V e.m.f. to its associated VHF receiver, the DSC equipment shall be capable of decoding the received message with a maximum permissible output character error rate of 10^{-2} .*

6.4 Receiver output

(See 8.4.1, 8.4.2, 8.4.10, 8.4.11)

(MSC.511(105)/C4.1) *For the reception of voice signals, the receiver shall be suitable for use with a loudspeaker and a telephone handset and shall be capable of providing power of at least 2 W to loudspeaker and at least 1 mW to the handset.*

(MSC.511(105)/C4.2) *An output shall be provided for DSC signals if the corresponding facility is not integrated.*

6.5 Permissible warming-up period

(MSC.511(105)/C5) See 5.4.

6.6 Immunity to interference

(See 8.4.4, 8.4.5, 8.4.6, 8.4.7, 8.4.8)

(MSC.511(105)/C6) *The immunity to interference of the receiver shall be such that the wanted signal is not seriously affected by unwanted signals.*

(ITU-R M.489-2/1.3.2) *The adjacent channel selectivity shall be at least 70 dB.*

(ITU-R M.489-2/1.3.3) *The spurious response rejection ratio shall be at least 70 dB.*

(ITU-R M.489-2/1.3.4) *The radiofrequency intermodulation rejection ratio shall be at least 65 dB.*

6.7 Controls

(MSC.511(105)/C7) See 5.6

6.8 Multiple watch facilities

6.8.1 General

(See 8.1.5)

(A.524(13)/1) *VHF radiotelephone equipment having multiple watch facilities shall comply with the following requirements.*

(A.524(13)/2.1) *The equipment shall include a provision for the automatic scanning of a priority channel and one additional channel only.*

(A.524(13)/2.2) *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.*

(A.524(13)/2.3) *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.*

(A.524(13)/2.4) *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 with the ship, e.g. the scanning facility shall be switched off automatically when the handset is off its hook. The scanning facility shall be switched on automatically when the handset is replaced on its hook.*

(A.524(13)/2.5) *Selection of the additional channel and, if provided, of the priority channel shall be possible at the operating position of the equipment. If the selection of the priority channel is not provided, the priority channel shall be channel 16.*

(A.524(13)/2.6) *When the scanning facility is in operation, the channel number of both channels on which the equipment is operating shall be clearly indicated simultaneously.*

(A.524(13)/2.7) *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.524(13)/2.8) *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.*

(A.524(13)/2.9) *At the operating position of a transceiver the selected additional channel shall be clearly indicated as being the operational channel of this receiver.*

6.8.2 Scanning characteristics

(See 8.4.14)

(A.524(13)/3.1) *When the scanning facility is switched on, the priority channel shall be sampled with a sampling frequency of not less than once per 2 s. If a signal is detected on the priority channel the receiver shall remain on this channel for the duration of that signal.*

(A.524(13)/3.2) *If a signal is detected on the additional channel the sampling of the priority channel shall continue, thus interrupting the reception on the additional 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.*

(A.524(13)/3.3) *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.*

(A.524(13)/3.4) *Means shall be provided to indicate the channel on which a signal is being received.*

7 Digital selective calling facility

(See 8.1.5)

7.1 DSC capabilities

(MSC.511(105)/D1.1) *The facility shall conform to the provisions of ITU-R Recommendation M.493 for Class A DSC equipment.*

(MSC.511(105)/D1.2) *The DSC facility shall comprise:*

- .1 means to decode and encode DSC messages;*
- .2 means necessary for composing the DSC message;*
- .3 means to verify the prepared message before it is transmitted;*
- .4 means to display the information contained in a received call in plain language;*
The display shall have a minimum of 160 characters in two or more lines
- .5 facilities to automatically update the ship's position and the time at which the position was determined from a suitable electronic position-fixing aid which may be an integral part of the equipment. For equipment which does not have an integral position-fixing aid, such facilities shall include a suitable interface conforming to the appropriate international standards;*
The integral electronic position-fixing aid shall comply with the applicable requirements of the IEC 61108 series.
- .6 means for the manual entry of position information and the time at which the position was determined; and*
- .7 means to activate an alert when no position data is received from the electronic position-fixing aid or, in the case of manual input, the position information is over four hours old. Any position information not updated for more than 23,5 hours shall be erased.*

7.2 Distress message storage

(MSC.511(105)/D2.1) *If the received messages are not printed immediately, sufficient capacity shall be provided to enable at least 20 received distress messages to be stored in the DSC facility.*

(MSC.511(105)/D2.2) *These messages shall be stored until read-out and shall be erased after 48 hours after their reception.*

7.3 DSC characteristics

The technical description of DSC is given in Annex 1 of Recommendation ITU-R M.493-16.

Tests for the DSC transmitter are given in 8.3.14, 8.3.15, 8.3.16, 8.3.17, and 8.3.18.

Further requirements specific to DSC are specified in Annex C.

For BAM related requirements specific to DSC, see Annex B.

8 Test methods and required test results

8.1 Test conditions

8.1.1 Normal and extreme test conditions

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

8.1.2 Test power source

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

8.1.3 Procedure for tests at extreme temperatures

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

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

8.1.4 General requirements

The equipment shall comply with the general requirements contained in IEC 60945, as applicable to the equipment category, for example "protected", "exposed".

For the purposes of IEC 60945 a performance check and performance test is defined as:

- a) the transmitter frequency error according to 8.3.2 and the output power of the transmitter according to 8.3.3 (high power only); and
- b) the receiver maximum usable sensitivity according to 8.4.3.

8.1.5 Tests by inspection

(See Clause 4, Clause 5, Clause 6, Clause 7)

Any requirement in Clause 4 to Clause 7 for which no test is specified in this Clause 8 shall be checked by inspection of the equipment, the manufacturing drawings or other relevant documents. The result of the inspection shall be stated in the test report.

8.2 General conditions of measurement

8.2.1 Arrangements for test signals applied to the receiver input

The source of test signals applied to the receiver input shall be connected to the receiver in such a way that the impedance presented to the receiver input is 50 Ω , irrespective of whether one or more signals are applied to the receiver simultaneously. The level of the test signals shall be expressed in terms of the 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.

8.2.2 Receiver squelch facility

Unless otherwise specified in this document, the squelch circuit shall be set inoperative for the duration of the test.

8.2.3 Normal test modulation

For normal test modulation, the modulating frequency shall be 1 kHz and the frequency deviation shall be ± 3 kHz. The test signal shall be substantially free from amplitude modulation.

8.2.4 Artificial antenna

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

8.2.5 Arrangements for test signals applied to the transmitter input

The transmitter audiofrequency modulation signal shall be supplied by a generator to an interface connected to the microphone input and this interface shall be provided by the manufacturer.

8.2.6 Transmitter output power

Unless otherwise specified in this document, the transmitter output power shall be at maximum for these tests.

8.2.7 Test of equipment with duplex filter

If the equipment is provided with a built-in or an external duplex filter, the requirements of this document shall be met when the measurements are carried out using the antenna terminals of the filter.

8.2.8 Test channels

For tests according to 8.3 and 8.4, test channels within the frequency range of the EUT shall include at least:

- a) the lowest frequency usable;
- b) the highest frequency usable;
- c) channel 16 (156,8 MHz); and

d) channel 70 (156,525 MHz).

Unless otherwise stated in this document, tests shall be carried out on channel 16 (156,8 MHz).

Field measurements and performance checks shall be made on a frequency other than channels 16 and 70.

8.2.9 Measurement uncertainty

Maximum values of absolute measurement uncertainties shall be as follows:

RF frequency	$\pm 1 \times 10^{-7}$
RF power	$\pm 0,75$ dB
Maximum frequency deviation:	
– within 300 Hz to 6 kHz of audiofrequency	± 5 %
– within 6 kHz to 25 kHz of audiofrequency	± 3 dB
Deviation limitation	± 5 %
Adjacent channel power	± 5 dB
Conducted spurious of transmitter	± 4 dB
Audio output power	$\pm 0,5$ dB
Amplitude characteristic of receiver limiter	$\pm 1,5$ dB
Sensitivity at 20 dB SINAD	± 3 dB
Conducted emission of receiver	± 3 dB
Two-signal measurement	± 4 dB
Three-signal measurement	± 3 dB
Radiated emission of transmitter	± 6 dB
Radiated emission of receiver	± 6 dB
Receiver desensitization at duplex operation	$\pm 0,5$ dB
Transmitter transient time	± 20 %
Transmitter transient frequency	± 250 Hz

8.3 Transmitter

8.3.1 Switching time

(See 5.6.1.1)

8.3.1.1 General

Switching time to change frequency is the time from the receive and/or transmit condition at one frequency to another. This includes manual channel selection time, the time to press the press-to-transmit (p.t.t.) switch, and receiver/transmitter response time.

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

8.3.1.2 Method of measurement

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

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

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

8.3.1.3 Required results

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

8.3.2 Frequency error

(See 5.2, 5.4)

8.3.2.1 General

The frequency error is the difference between the measured carrier frequency and the assigned frequency.

8.3.2.2 Method of measurement

The carrier frequency shall be measured in the absence of modulation with the transmitter connected to an artificial antenna. The measurement shall be carried out under normal test conditions and extreme test conditions as defined in IEC 60945, of dry heat and the upper limit of supply voltage applied simultaneously and low temperature and the lower limit of supply voltage applied simultaneously.

8.3.2.3 Required results

The frequency error, after the warming-up period specified in 5.4, shall be within $\pm 1,5$ kHz.

8.3.3 Carrier power

(See 5.3, 5.5)

8.3.3.1 General

The carrier power is the average power supplied to the artificial antenna during one radiofrequency cycle in the absence of modulation.

8.3.3.2 Method of measurement

The transmitter shall be connected to an artificial antenna and the power delivered to this artificial antenna shall be measured. The measurements shall be carried out under normal test conditions and extreme test conditions as defined in IEC 60945, of dry heat and the upper limit of supply voltage applied simultaneously and low temperature and the lower limit of supply voltage applied simultaneously.

8.3.3.3 Required results

8.3.3.3.1 Normal test conditions

The carrier power with the output power switch set at maximum, shall remain between 6 W and 25 W during a period as specified in 5.5. The measured power is considered to be the rated output power. The carrier power with the output power switch set at minimum shall remain between 0,1 W and 1,0 W. At the end of the period specified in 5.5 the transmitter shall stop transmitting.

8.3.3.3.2 Extreme test conditions

With the output power switch set at maximum, the carrier power shall remain between 6 W and 25 W during a period as specified in 5.5 and be within +2 dB or –3 dB of the carrier power measured under the normal test condition. With the output power switch set at minimum, the carrier power shall remain between 0,1 W and 1 W. At the end of the period specified in 5.5 the transmitter shall stop transmitting.

8.3.4 Frequency deviation

(See 5.1.2, 5.1.3)

8.3.4.1 General

The frequency deviation is the difference between the instantaneous frequency of the modulated radiofrequency signal and the carrier frequency.

8.3.4.2 Maximum permissible frequency deviation

8.3.4.2.1 Method of measurement

The frequency deviation shall be measured at the output with the transmitter connected to an artificial antenna, by means of a deviation meter capable of measuring the maximum deviation, including the frequency deviation 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. This test shall be carried out with the output power switch set at both maximum and minimum.

8.3.4.2.2 Required results

The maximum permissible frequency deviation shall be ± 5 kHz.

8.3.4.3 Reduction of frequency deviation at modulation frequencies above 3 kHz

8.3.4.3.1 Method of measurement

The transmitter shall be operated under normal test conditions and terminated with an artificial antenna. The transmitter shall be modulated with normal test modulation. With the modulation signal at a constant input level, the frequency shall be varied from 3 kHz to 25 kHz and the frequency deviation shall be measured.

8.3.4.3.2 Required results

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 (see Figure 2).

For a modulation frequency of 6 kHz, the frequency deviation shall not exceed $\pm 1,5$ kHz (see Figure 2).

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 decibels) 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 (see Figure 2).

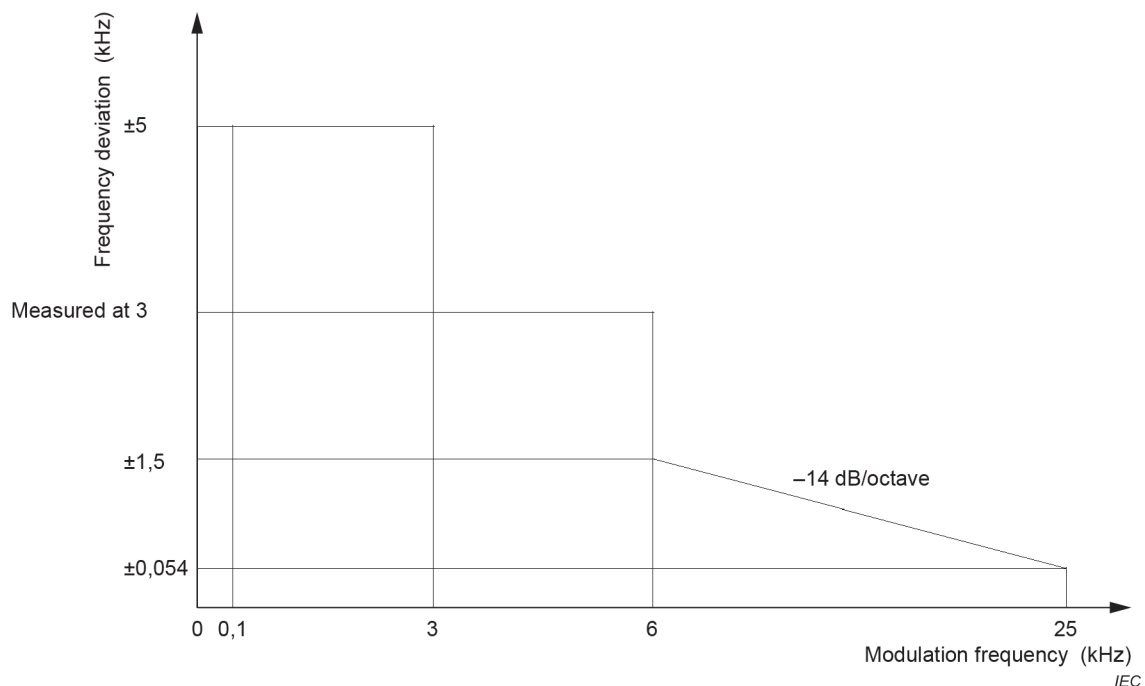


Figure 2 – Transmitter permissible frequency deviation

8.3.5 Limitation characteristics of the modulator

(See 5.1.2)

8.3.5.1 General

This characteristic expresses the ability of the transmitter to be modulated near the maximum permissible deviation specified in 8.3.4.

8.3.5.2 Method of measurement

A modulation signal at a frequency of 1 kHz shall be applied to the transmitter, and its level adjusted so that the frequency deviation is ± 1 kHz. The level of the modulation signal shall then be increased by 20 dB and the deviation shall again be measured. This test shall be conducted under normal test conditions and extreme test conditions as defined in IEC 60945, of dry heat and the upper limit of supply voltage applied simultaneously and low temperature and the lower limit of supply voltage applied simultaneously.

8.3.5.3 Required results

The frequency deviation shall be between $\pm 3,5$ kHz and ± 5 kHz.

8.3.6 Sensitivity of modulator, including microphone

(See 5.1.2)

8.3.6.1 General

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

8.3.6.2 Method of measurement

An acoustic signal with a frequency of 1 kHz and sound level of 94 dBA relative to 2×10^{-5} Pa shall be applied to the microphone. The resulting deviation shall be measured.

8.3.6.3 Required results

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

8.3.7 Audiofrequency response

(See 5.1.3)

8.3.7.1 General

The audiofrequency response expresses the ability of the transmitter to operate without excessive degradation of the frequency response, as a function of the modulation frequency.

8.3.7.2 Method of measurement

A modulation signal, at a frequency of 1 kHz adjusted in level to produce a frequency deviation of ± 1 kHz, is applied to the transmitter. The modulation frequency shall then be varied between 300 Hz and 3 kHz, keeping the audio input level constant.

8.3.7.3 Required results

The modulation index shall be constant and equal to its value at 1 kHz within the limits of +1 dB or –3 dB.

NOTE Modulation index is the ratio between the frequency deviation and the modulation frequency.

8.3.8 Audiofrequency harmonic distortion of the emission

(See 5.1.3)

8.3.8.1 General

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

8.3.8.2 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.

Under normal test conditions, the radiofrequency signal shall be modulated successively at frequencies of 300 Hz, 500 Hz and 1000 Hz with a constant modulation index of three. The distortion of the audiofrequency signal shall be measured at the frequencies specified above.

Under extreme test conditions as defined in IEC 60945, of dry heat and the upper limit of supply voltage applied simultaneously and low temperature and the lower limit of supply voltage applied simultaneously, the measurements shall be carried out at 1 kHz with a frequency deviation of ± 3 kHz.

8.3.8.3 Required results

The audiofrequency harmonic distortion shall not exceed 10 %.

8.3.9 Adjacent channel power

(See 5.3)

8.3.9.1 General

The adjacent channel power is the 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.

8.3.9.2 Method of measurement

The adjacent channel power shall be measured with a power measuring receiver, referred to as the "receiver", which consists of a mixer, an IF filter, an oscillator, an amplifier, a variable attenuator and an RMS value indicator. Instead of the variable attenuator with the RMS value indicator it is possible to use an RMS voltmeter calibrated in decibels. The technical characteristics of the power measuring receiver shall be as given in Annex A.

The procedure is as follows:

- a) the transmitter shall be operated at the carrier power determined in 8.3.3 under normal test conditions. The output of the transmitter shall be linked to the input of the "receiver" by a connecting device such that the impedance presented to the transmitter is 50 Ω and the level at the "receiver" input is appropriate;
- b) with the transmitter unmodulated, 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. The measurement may alternatively be made with the transmitter modulated with normal test modulation, in which case this fact shall be recorded with the test results;
- e) 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;
- f) the transmitter shall be modulated with 1,25 kHz at a level which is 20 dB higher than that required to produce a ± 3 kHz deviation;
- g) the "receiver" variable attenuator shall be adjusted to obtain the same meter reading as in step b) or a known relation to it;
- h) 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;
- i) the measurement shall be repeated with the "receiver" tuned to the other side of the carrier.

8.3.9.3 Required results

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

8.3.10 Conducted spurious emissions conveyed to the antenna

(See 5.3)

8.3.10.1 General

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.

8.3.10.2 Method of measurement

Conducted spurious emissions shall be measured with the unmodulated transmitter connected to the artificial antenna. The measurement shall be made over a frequency range from 150 kHz to 2 GHz, excluding the channel on which the transmitter is operating and its adjacent channels.

8.3.10.3 Required results

The power of any spurious emission on any discrete frequency shall not exceed 0,25 μW in the frequency range 150 kHz to 1 GHz and 1 μW in the frequency range 1 GHz to 2 GHz.

8.3.11 Residual modulation of the transmitter

(See 5.1.2)

8.3.11.1 General

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

8.3.11.2 Method of measurement

The normal test modulation shall be applied to the transmitter. The radiofrequency 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 signal shall be measured by using an RMS voltmeter. The modulation shall then be switched off and the level of the residual audiofrequency signal at the output shall be measured again.

8.3.11.3 Required results

The residual modulation shall not exceed –40 dB.

8.3.12 Transient frequency behaviour of the transmitter

(See 5.2)

8.3.12.1 General

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 radiofrequency output power is switched on and off (see Figure 3).

- t_{on} according to the method of measurement described in 8.3.12.2 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 7;
- t_2 period of time starting at the end of t_1 and finishing according to Table 7;
- t_{off} switch-off instant defined by the condition when the output power falls below 0,1 % of the nominal power;
- t_3 period of time finishing at t_{off} and starting according to Table 7.

Table 7 – Transmitter transient timing (ms)

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

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

During the period t_2 the frequency difference shall not exceed the value of half a channel separation.

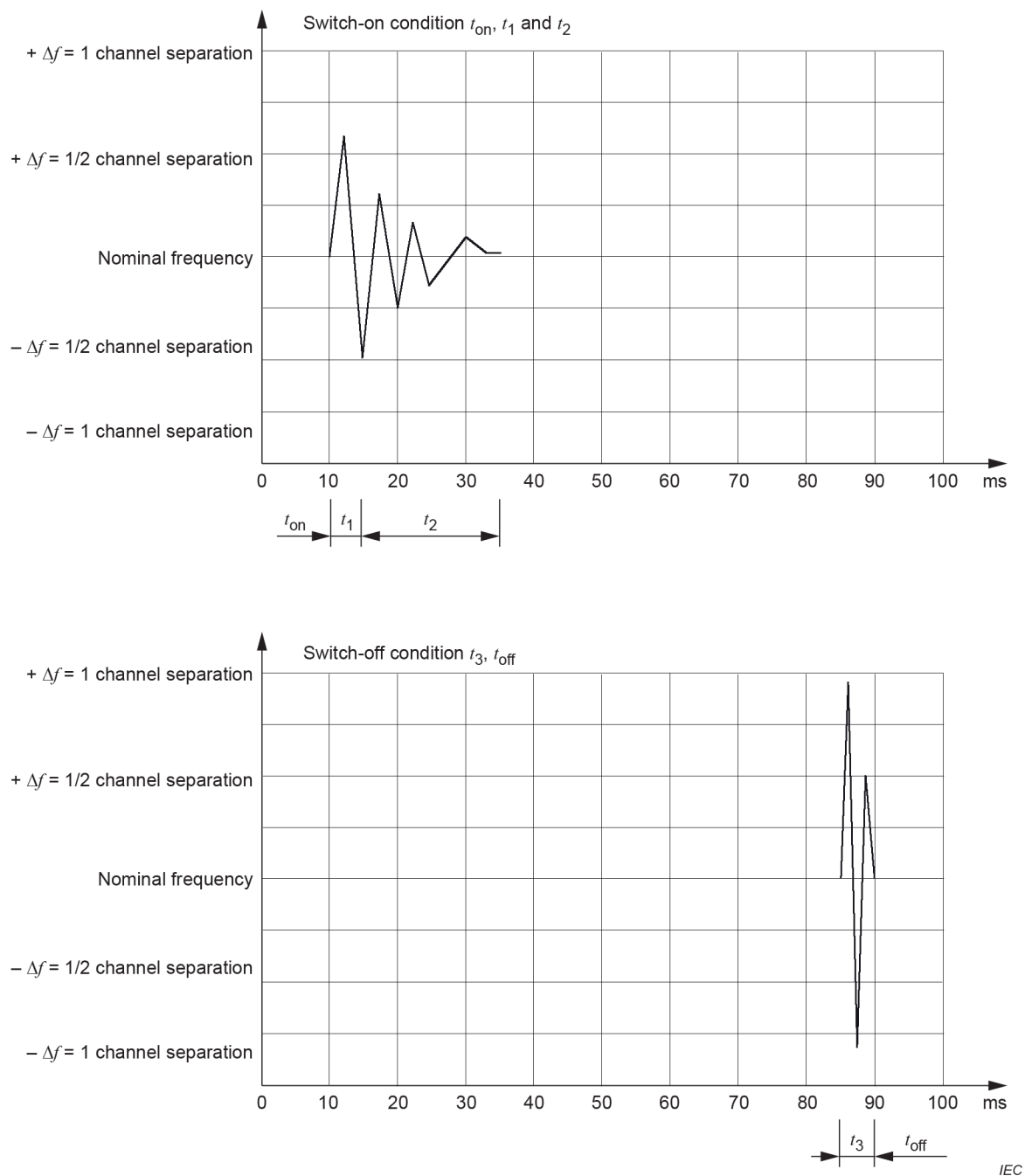
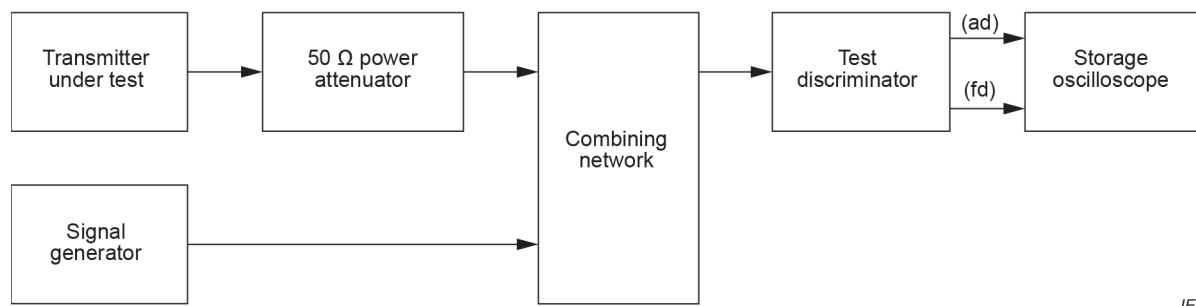


Figure 3 – Storage oscilloscope view t_1 , t_2 and t_3

8.3.12.2 Method of measurement

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



IEC

Figure 4 – Test set-up for measuring transient frequency behavior

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

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

The amplitude difference (ad) (see Figure 4) and the frequency difference (fd) (see Figure 4) output of the test discriminator shall be connected to a storage oscilloscope. The storage oscilloscope shall be set to display the channel corresponding to the (fd) input up to ± 1 channel frequency difference, corresponding to the relevant channel separation, from the nominal frequency.

The storage oscilloscope shall be set to a sweep rate of 1 ms per 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 level, rising.

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

The moment when the 1 kHz test signal is completely suppressed is considered to provide t_{on} . The period of time t_1 and t_2 as defined in Table 7 shall be used to define the appropriate template.

The result shall be recorded as frequency difference versus time.

The transmitter shall remain switched on.

The storage oscilloscope shall be set to trigger on the channel corresponding to the amplitude difference (ad) input at a high level, decaying and set so that the triggering occurs at one 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 7 shall be used to define the appropriate template.

The result shall be recorded as frequency difference versus time.

8.3.12.3 Required results

During the period of time t_1 and t_3 the frequency difference shall not exceed the value of one channel separation. The frequency difference, after the end of t_2 , shall be within the limit of the frequency error of 8.3.2.

During the period of time t_2 the frequency difference shall not exceed the value of half a channel separation. Before the start of t_3 the frequency difference shall be within the limit of the frequency error of 8.3.2.

The required results are illustrated in Figure 3.

8.3.13 Protection of the transmitter

(See 5.7)

8.3.13.1 Antenna terminals

8.3.13.1.1 General

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

8.3.13.1.2 Method of measurement

After the transmitter has been turned on, tuned and turned off, the antenna terminals shall be short-circuited. Then the transmitter shall be turned on for a period of 5 min. Then the transmitter shall be turned off, the antenna terminals shall be open-circuited, and the transmitter shall be turned on for a period of 5 min.

It is only necessary to carry out the test on one frequency and mode of operation.

8.3.13.1.3 Required results

The transmitter shall not be damaged and it shall be able to operate normally for all available modes of operation.

8.3.13.2 Standing wave ratio

8.3.13.2.1 General

If the standing wave ratio (SWR) becomes too high, the power of the transmitter shall be automatically reduced without stopping the transmission and an appropriate alert shall be initiated.

8.3.13.2.2 Method of measurement

The transmitter shall be connected to the artificial antenna which is set for the standing wave ratio (SWR) of 3 or higher and transmitted for a period of 5 min with normal test modulation.

It is only necessary to carry out the test on one frequency and mode of operation.

8.3.13.2.3 Required results

Confirm by observation that once test antenna with high SWR remains connected, the transmitter automatically reduces the output power without stopping the transmission and initiates an appropriate alert (see Annex B). Confirm by observation that after removal of the high SWR conditions, the transmitter is able to operate normally for all available modes of operation.

8.3.14 Frequency error (demodulated signal)

(See 7.3)

8.3.14.1 General

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

8.3.14.2 Method of measurement

The transmitter shall be connected to the artificial antenna. The transmitter frequency shall be set to channel 70 and the transmitter shall be set to transmit continuous B or Y state.

The measurement shall be carried out by measuring the demodulated output for both B and Y state.

The measurement shall be carried out under normal test conditions and extreme test conditions applied simultaneously.

8.3.14.3 Required results

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

8.3.15 Modulation index

(See 7.3)

8.3.15.1 General

The modulation index of the modulated signal is determined as the ratio between the frequency deviation and the frequency of the modulation signal.

8.3.15.2 Method of measurement

The equipment shall be set to transmit continuous B and then Y state signal.

The transmitter output is connected to a linear FM demodulator. The frequency deviation is measured and the modulation index is calculated for both B and Y state.

8.3.15.3 Required results

The modulation index shall be 2,0 with a relative tolerance of $\pm 10\%$.

8.3.16 Modulation rate

(See 7.3)

8.3.16.1 General

The modulation rate is the bit stream speed measured in bit/s.

8.3.16.2 Method of measurement

The equipment shall be set to transmit continuous dot pattern. The transmitter output is connected to a linear FM demodulator and the frequency is measured.

8.3.16.3 Required results

The frequency shall be $600 \text{ Hz} \pm 0,018 \text{ Hz}$ corresponding to modulation rate of $1\,200 \text{ bit/s} \pm 0,036 \text{ bit/s}$.

8.3.17 Residual modulation

(See 7.3)

8.3.17.1 General

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

8.3.17.2 Method of measurement

The transmitter output is connected to a linear FM demodulator with de-emphasis filter of first order. The filtered output is led on to the second linear FM demodulator. The output from the second demodulator is filtered out by second order low filter with cut off frequency of 3 kHz.

The RMS level of the filtered output signal from the second demodulator is measured during transmission of continuous dot pattern and continuous B or Y state respectively.

The ratio of the two RMS levels shall be determined.

8.3.17.3 Required results

The residual modulation shall be greater than -26 dB .

8.3.18 Modulator attack time

(See 7.3)

8.3.18.1 General

The modulator attack time is the time elapsed between keying the transmitter and the transmitter being correctly modulated.

8.3.18.2 Method of measurement

Arrangements for monitoring the transmitter output are shown in Figure 5. The transmitter output is coupled by suitable means to a wideband FM-demodulator, and the transmitter RF signal is used for external trigger to a storage oscilloscope connected to the output of the FM-demodulator. The oscilloscope is set for single trigger mode.

The test shall be performed on channel 70.

A DSC call (for guidance, see 8.5.1) shall be initiated and the measurement carried out.

The modulator attack time t_{att} is the elapsed time from when the RF carrier is present, until the demodulated 1 300 Hz and 2 100 Hz audio tones are present.

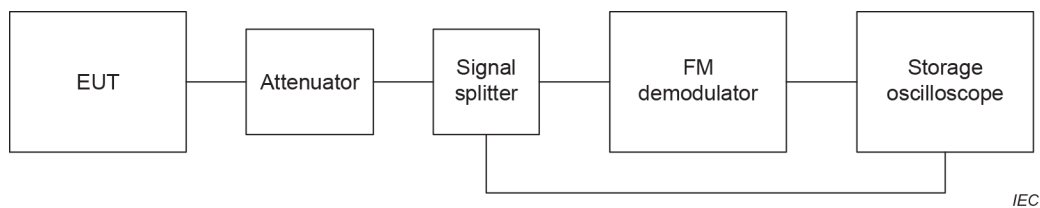


Figure 5 – Modulator attack time test configuration

8.3.18.3 Required results

The time t_{att} shall be less than 90 ms.

8.4 Audio general receiver

8.4.1 Harmonic distortion and rated audiofrequency output power

(See 6.4)

8.4.1.1 General

The harmonic distortion at the receiver output is defined as the ratio, expressed as a percentage, of the total RMS voltage of all the harmonic components of the modulation audiofrequency to the total RMS 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 document are met.

8.4.1.2 Method of measurement

A test signal of +100 dB μ V, at a carrier frequency equal to the nominal frequency of the receiver and modulated by the normal test modulation shall be applied to the receiver input.

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

Under normal test conditions, the test signal shall be modulated successively at 300 Hz, 500 Hz and 1 kHz with a constant modulation index of three. The harmonic distortion and audiofrequency output power shall be measured at all the frequencies specified above.

Under extreme test conditions as defined in IEC 60945, of dry heat and the upper limit of supply voltage applied simultaneously and low temperature and the lower limit of supply voltage applied simultaneously, the test shall be carried out at the nominal frequency of the receiver and at the nominal frequency $\pm 1,5$ kHz. For these tests, the modulation shall be 1 kHz and the frequency deviation shall be ± 3 kHz.

8.4.1.3 Required results

The rated audiofrequency output power shall be at least 2 W in the loudspeaker and 1 mW in the handset (earphone).

The harmonic distortion shall not exceed 10 %.

8.4.2 Audiofrequency response

(See 6.4)

8.4.2.1 General

The audiofrequency response is defined as the variation in the audiofrequency output level of the receiver as a function of the modulation frequency of the radiofrequency signal with constant deviation at the input.

8.4.2.2 Method of measurement

A test signal of +60 dB μ V, at a carrier frequency equal to the nominal frequency of the receiver, shall be applied to the receiver input. The audiofrequency power control of the receiver shall be set so as to produce a level equal to 50 % of the rated audiofrequency output power (see 8.4.1) when normal test modulation is applied in accordance with 8.2.3. This setting shall remain unchanged during the test.

The frequency deviation shall then be reduced to ± 1 kHz. 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 the same frequency as the nominal frequency of the receiver $\pm 1,5$ kHz.

8.4.2.3 Required results

The receiver 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.

The required limits are illustrated in Figure 6.

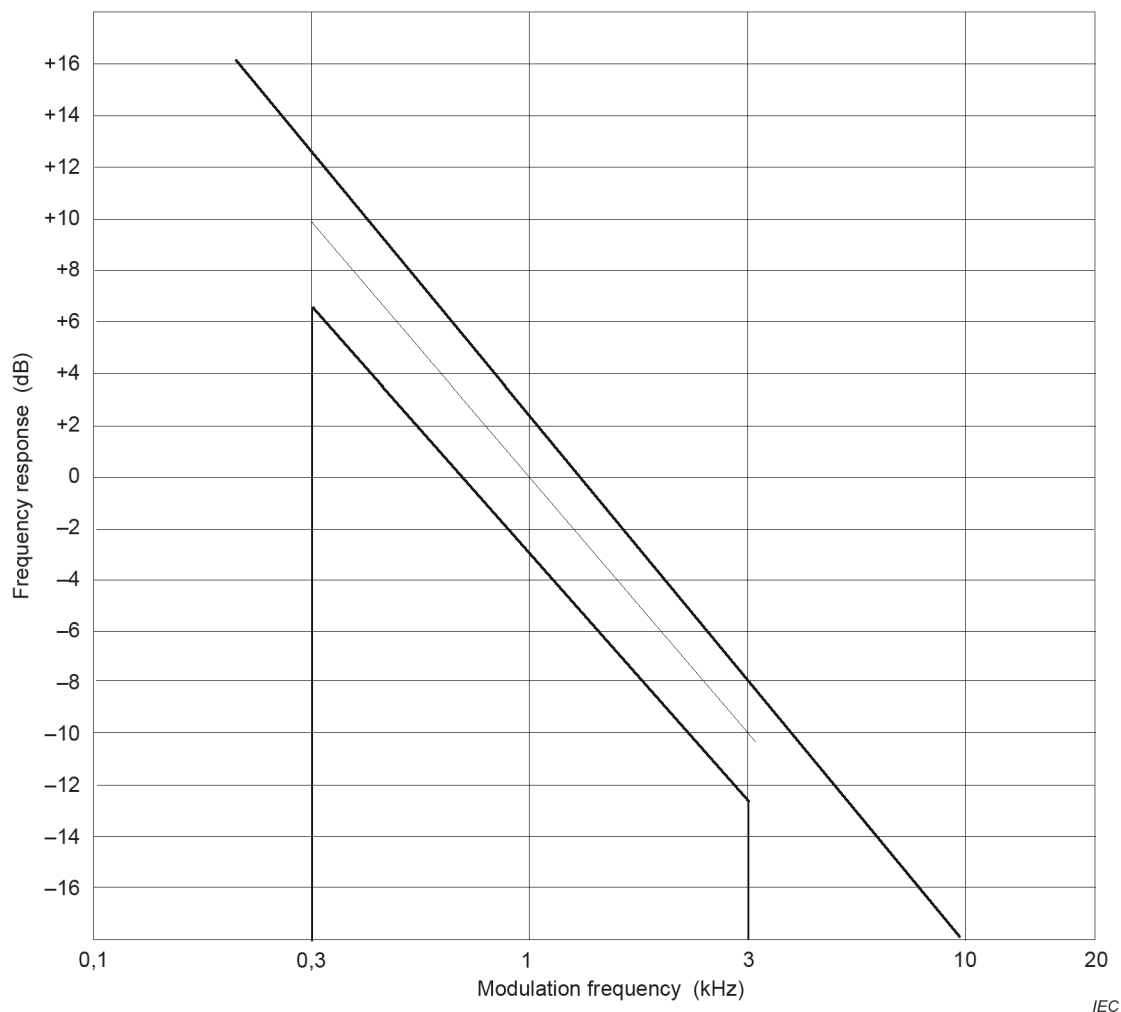


Figure 6 – Receiver audiofrequency response

8.4.3 Maximum usable sensitivity

(See 6.3.1)

8.4.3.1 General

The maximum usable sensitivity 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, will produce at the receiver output in all cases, an audiofrequency output power equal to 50 % of the rated output power and a SINAD ratio, psophometrically weighted such as described in Recommendation ITU-T O.41, of 20 dB.

For EUT fitted with a duplex filter see also 8.2.7.

8.4.3.2 Method of measurement

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