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European Standard (Telecommunications series)

Radio Equipment and Systems (RES);
Technical characteristics and methods of measurement
for shipborne watchkeeping receivers
for reception of Digital Selective Calling (DSC)
in the maritime MF, MF/HF and VHF bands

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ETSI Secretariat

Postal address
F-06921 Sophia Antipolis Cedex - FRANCE

Office address
650 Route des Lucioles - Sophia Antipolis
Valbonne - FRANCE
Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16
Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

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c= fr; a=atlas; p=etsi; s=secretariat

Internet
secretariat@etsi.fr
http://www.etsi.fr

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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Radio Equipment and Systems (RES), and is now submitted for the Public Enquiry phase of the ETSI standards Two-step Approval Procedure (TAP).

Proposed national transposition dates	
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1 Scope

The present document states the minimum operational and performance requirements for shipborne receivers intended to be connected to an external installation, including a decoder for Digital Selective Calling (DSC), and used as receivers for watchkeeping DSC on board ships operating in the mobile MF, MF/HF and VHF band allocated in the ITU Radio Regulations [1] to the maritime mobile service, both in connection with distress and safety communication and in connection with general communication.

These requirements include the relevant provisions of the ITU Radio Regulations [1], ITU Recommendations ITU-R M.493-7 [4], ITU-R M.541-6 [5] and ITU-R M.1082 [6] and the International Maritime Organisation (IMO) Resolutions A.803(19) [8], A.804(19) [9], A.806(19) [10] and IMO COM/Circ 105 of 6.8.1991 [11].

The present document specifies also technical characteristics, methods of testing and required test results for dedicated watchkeeping receivers for use with radio installations in the GMDSS as required by chapter IV of the International Convention for Safety of Life at Sea (SOLAS) [3].

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

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

2 Normative references

The present document incorporates by dated or undated reference provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent references to, or revisions of any of these publications apply to the present document only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] ITU Radio Regulations.

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

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

[4] Recommendation ITU-R M.493-7 (1995): "Digital selective-calling system for use in the maritime mobile service".

[5] Recommendation ITU-R M.541-6 (1995): "Operational procedures for the use of digital selective-calling (DSC) equipment in the maritime mobile service".

[6] Recommendation ITU-R M.1082 (1993): "International maritime MF/HF radiotelephone system with automatic facilities based on DSC signalling format".

[7] ISO 3791 (1976): "Office machines and data processing equipment -- Keyboard layouts for numeric applications".

[8] IMO Resolution A.803(19): "Performance Standards for Shipborne VHF Radio Installations capable of Voice Communications and Digital Selective Calling".

[9] IMO Resolution A.804(19): "Performance Standards for Shipborne MF Radio Installations capable of Voice Communications and Digital Selective Calling".

[10] IMO Resolution A.806(19): "Performance Standards for Shipborne MF/HF Radio Installations capable of Voice Communications, Narrow-Band Direct-Printing and Digital Selective Calling".

[11] IMO COM/Circ 105 (6.8.1991): "Clarification of certain provisions of the 1988 SOLAS Amendments for the GMDSS".

[12] IEC 1162-1 (1995): "Maritime navigation and radiocommunication equipment and systems - Digital interfaces - Part 1: Single talker and multiple listeners".

[13] ETR 028: "Radio Equipment and Systems (RES); Uncertainties in the measurement of mobile radio equipment characteristics".

[14] Recommendation ITU-T V.28 (1993): "Electrical characteristic for unbalanced double-current interchange circuits".

[15] IEC 417 (1973): "Graphical symbols for use on equipment. Index, survey and compilation of the single sheet.".

[16] Recommendation ITU-R SM.332-4 (1978): "Selectivity of receivers".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following definitions apply:

assigned frequency: The centre of the frequency band assigned to a station.

continuous watch: Continuous watch means that the radio watch concerned is not interrupted other than for brief intervals when the ship's receiving capability is impaired or blocked by its own communications or when the facilities are under periodical maintenance or check.

F1B: Frequency modulation with digital information, without a sub-carrier for automatic reception.

G2B: Phase-modulation with digital information, with a sub-carrier for automatic reception.

J2B: Single sideband with digital information, with the use of a modulating sub-carrier, with the carrier suppressed to at least 40 dB below peak envelope power.

performance check: A check of calling sensitivity.

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ac	alternating current
dc	direct current
DSC	Digital Selective Calling
EUT	Equipment Under Test
e.m.f.	electromotive force
FSK	Frequency Shift Keying
GMDSS	Global Maritime Distress and Safety System
HF	High Frequency
IF	Intermediate Frequency
MF	Medium Frequency
MF/HF	Medium and High Frequency
RF	Radio Frequency
r.m.s.	root mean square
SOLAS	(International Convention for the) Safety of Life at Sea
VHF	Very High Frequency

4 General and operational requirements

4.1 General

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

4.2 Construction

4.2.1 General

The equipment shall be so constructed that it is capable of keeping continuous watch on relevant DSC channels (see subclause 5.1) and of being operated readily.

4.2.2 Design

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

4.2.3 Accessibility

All parts of the equipment that are subject to inspection and maintenance adjustments, shall be easily accessible. Components shall be easily identifiable either by markings within the equipment, or with the aid of technical descriptions.

4.2.4 Calibration and maintenance

The equipment shall be so constructed that its main modules can easily be replaced and put into operation without elaborate recalibration or readjustment.

4.2.5 Antenna static protection

In order to protect against damage due to static voltages that may appear at the input of the receiver, there shall be a DC path from the antenna terminal to ground not exceeding 100 kΩ.

4.2.6 Digital input panels

Where a digital input panel with the digits "0" to "9" is provided, the digits should be arranged to conform with Recommendation ITU-T E.161 [2]. However, where an alphanumeric keyboard layout, as used on office machinery and data processing equipment, is provided, the digits "0" to "9" may, alternatively, be arranged to conform with ISO 3791 [7].

4.3 Controls and indicators

4.3.1 General

The number of operational controls, their design and manner of functioning, location, arrangement and size should provide for simple, quick and efficient operation. All operational controls shall permit normal adjustments to be easily performed and shall be arranged in a manner which minimises the risk of inadvertent activation.

4.3.2 Identification

All operational controls and indicators shall be easy to identify and read from the position at which the equipment is normally operated.

The controls and indicators shall be identified in English. Symbols as specified in IEC 417 [15] may be used in addition.

4.3.3 Protection against possible maladjustment

Controls not required for normal operation shall not be readily accessible.

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

4.3.4 Light sources

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

4.3.5 Operation

The equipment shall be so designed that misuse of the controls cannot cause injury to personnel.

4.4 Software

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

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

A watchdog circuit shall be provided to monitor the operation of the equipment at appropriate regular intervals and to activate an alarm or signal in the event of a failure which is not recoverable automatically.

4.5 Memory

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

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

4.6 Interfaces

4.6.1 DSC signal output; analogue interface

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

The audio frequency subcarrier shall be 1 700 Hz and the sideband shall be preserved.

4.6.2 DSC signal output; digital interface

For equipment designed for binary signal output to an external DSC decoder, the logic level of the digital signal output shall be compatible with Recommendation ITU-T V.28 [14].

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

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

4.6.3 Operational interfaces

Where provided:

- interfaces for stop and start of the scanning sequence of scanning receivers shall comply with Recommendation ITU-T V.28 [14]; and

- interfaces for frequency control or read-out of scanning receivers shall comply with IEC 1162-1 [12].

Additional interfaces may be provided but connection of, or failure within any external circuits shall not degrade the performance of the equipment.

4.7 Marking and identification

Each unit of the equipment shall be marked externally with the following information which, shall be clearly visible:

1) identification of the manufacturer;

2) equipment type designation or model identification;

3) serial number of the unit;

4) details of the power supply.

Additionally, the marking may be presented on a display.

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

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

For fixed-frequency receivers, the DSC frequencies or channels on which the equipment may operate shall be clearly indicated. For programmable scanning receivers, it shall be possible to display the programmed frequencies or to print them via an external controller.

4.8 Instructions

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

Operating and servicing manuals shall:

- be written at least in English;
- identify whether the equipment is intended to be protected from or exposed to the weather;
- in the case of equipment so designed that fault diagnosis and repair down to component level are practicable, the instructions shall provide full circuit diagrams, component layouts, a component parts list; and
- in the case of equipment containing complex modules in which fault diagnosis and repair down to component level are not practicable, the instructions shall contain sufficient information to enable a defective complex module to be located, identified and replaced. Other modules and those discrete components which do not form part of modules shall also meet the requirements above.

4.9 Warming-up period

The equipment shall be operational one minute after switching on.

4.10 Safety precautions

4.10.1 Excessive current and voltage

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

4.10.2 Earthing

Means shall be provided for earthing exposed metallic parts of the equipment, but this shall not cause any terminal of the source of electrical energy to be earthed.

4.10.3 Protection

As far as practicable, accidental access to dangerous voltages shall be prevented. All parts and wiring in which the direct or alternating voltages or both (other than radio frequency voltages) combine to give a peak voltage greater than 50 V, shall be protected against accidental access and shall be isolated automatically from all sources of electrical energy when the protective covers are removed.

Alternatively, the equipment shall be so constructed that access to such voltages can only be gained after having used a tool for this purpose, such as a spanner or screwdriver, and warning labels shall be prominently displayed both within the equipment and on protective covers.

4.11 Compass safe distance

The compass safe distance to a standard or steering magnetic compass shall be stated on the equipment or in the manual.

5 Technical requirements

5.1 Frequency bands and channels

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

MF:	1 605 kHz	to	4 000 kHz;
HF:	4 MHz	to	27,5 MHz; and
VHF:	156 MHz	to	174 MHz.

MF and HF DSC frequencies shall be designated in terms of the assigned frequency.

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

The MF and HF DSC distress calling frequencies are:

- 2 187,5 kHz;
- 4 207,5 kHz;
- 6 312 kHz;
- 8 414,5 kHz;
- 12 577 kHz; and
- 16 804,5 kHz.

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

- 2 177 kHz;
- 4 219,5 kHz;
- 6 331 kHz;
- 8 436,5 kHz;
- 12 657 kHz;
- 16 903 kHz;
- 19 703,5 kHz;
- 22 444 kHz; and
- 26 121 kHz.

Additionally allocated frequencies are:

- 4 220 kHz;
- 6 331,5 kHz;
- 8 437 kHz;
- 12 657,5 kHz;
- 16 903,5 kHz;
- 19 704 kHz;
- 22 444,5 kHz;
- 26 121,5 kHz;
- 4 220,5 kHz;
- 6 332 kHz;
- 8 437,5 kHz;
- 12 658 kHz;
- 16 904 kHz;
- 19 704,5 kHz;
- 22 445 kHz;
- 26 122 kHz.

For general communication calling only, other MF/HF working frequencies and channels of appendix 18 of the Radio Regulations [1] may also be used.

Watchkeeping receivers for the MF DSC frequency for distress, urgency and safety calling shall be a single-frequency receiver for 2 187,5 kHz.

MF and HF scanning receivers shall be designed for scanning of up to 6 frequencies for either DSC distress calling only, or for DSC general communication calling only.

On VHF the calling channel for distress, urgency and safety calling and for general communication calling is channel 70.

Watchkeeping receivers for VHF distress, emergency and safety calling shall be single-channel receivers set to channel 70.

For general communication calling only, VHF watchkeeping receivers may be switched to other channels of appendix 18 of the Radio Regulations [1].

5.2 Mode of reception

Equipment for reception of MF/HF DSC transmissions shall provide for classes of emission F1B or J2B.

Equipment for reception of VHF DSC transmissions shall provide for class of emission G2B.

5.3 Scanning receivers

5.3.1 Scanning frequencies

Scanning watch receivers shall be dedicated to either scan DSC distress frequencies or to scan DSC frequencies for general communication.

5.3.1.1 DSC distress frequencies

Scanning watch receivers for MF/HF DSC distress frequencies shall scan the frequencies 2 187,5 kHz and 8 414,5 kHz and at least one other HF DSC distress frequency listed in subclause 5.1.

Other HF DSC distress frequencies listed in subclause 5.1 may be added up to a total of 6 frequencies in the scanning sequence.

5.3.1.2 DSC frequencies for general communication

Scanning watch receivers for MF and HF DSC frequencies for general communication may scan any general communication frequency added up to a total of 6 frequencies in the scanning sequence.

5.3.2 Stop/start of scanning

The scanning receiver shall be provided with means for stop and start of the scanning under the control of an external DSC decoder/encoder equipment. The interface and protocol for such control shall be in accordance with IEC 1162-1 [12].

The stop signal shall be logic "0" and the start signal shall be logic "1".

The start and stop signals may be substituted by direct frequency commands in accordance with IEC 1162-1 [12].

5.3.3 Frequency information

Means shall be provided for automatic transfer of information of the frequency or channel on which the scanning has stopped for use and display in an external installation (normally an independent DSC equipment). The interface for such transfer shall be in accordance with IEC 1162-1 [12].

6 General test conditions

6.1 General

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

6.2 Test power source

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

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

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

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

6.3 Normal test conditions

6.3.1 Normal temperature and humidity

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

- temperature: +15°C to +35°C;
- relative humidity: 20 % to 75 %.

6.3.2 Normal test power source

6.3.2.1 ac voltage and frequency

The normal test voltage for equipment to be connected to the ac power supply shall be the declared voltage or any one of the declared voltages for which the equipment was designed.

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

6.3.2.2 Secondary battery power sources

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

6.3.2.3 Other power sources

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

6.4 Extreme test conditions

6.4.1 Extreme temperature tests

When testing under extreme conditions, the measurements shall be carried out at -15°C and +55°C for equipment intended to be protected from the weather, and 25°C and +55°C for equipment intended to be exposed to the weather.

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

6.4.2 Extreme values of test power source

6.4.2.1 ac voltage and frequency

The extreme test voltages for equipment to be connected to an ac power supply shall be the normal voltage ±10 %.

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

6.4.2.2 Secondary battery power sources

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

6.4.2.3 Other power sources

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

6.5 Connection of test signals to the receiver

For the purpose of conformance testing, the receiver shall be connected to sources of test signals such that the impedance presented to the receiver input is 50 Ω resistive.

NOTE: this does not imply that the receiver should operate satisfactorily only with antennas having 50 Ω impedance.

6.5.1 Sources

Test signals shall be connected through a network as specified in subclause 6.5. This requirement shall be met irrespective of whether one, two or more test signals are applied to the receiver simultaneously. In the case of multiple test signals, steps shall be taken to prevent any undesirable effects due to interaction between the signals in the generators or other sources.

6.5.2 Levels

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

6.6 Testing frequencies

6.6.1 General test frequencies

Unless otherwise stated, the testing frequencies shall be:

- MF band: 2 187,5 kHz or 2 177 kHz;
- HF band: 8 414,5 kHz or 8 436,5 kHz;
- VHF band: 156,525 MHz (channel 70).

6.6.2 Additional test frequencies for HF equipment

Where stated, the testing frequencies for HF equipment shall additionally be:

- for equipment intended for distress/safety purposes, the test frequencies shall be the DSC distress/safety frequencies 4 207,5 kHz, 6 312 kHz, 12 577 kHz and 16 804,5 kHz as applicable for the range of the equipment (see subclause 5.1);
- for the equipment not intended for distress and safety purposes, the test frequencies shall be any of the DSC calling frequencies in each of the 4, 6, 12, 16, 18, 22 and 26 MHz bands as applicable for the range of the equipment (see subclause 5.1).

6.7 Test signals

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

A standard test signal shall simulate DSC modulation as specified in Recommendation ITU-R M.493-7 [4] and shall be of sufficient duration for the measurements to be performed or it shall be possible to repeat it without interruption as long as necessary to make the measurement.

6.7.1 Standard test signal No. 1

Standard test signal No. 1 for MF/HF DSC watchkeeping receiver shall be an RF signal FSK modulated with a frequency shift of ±85 Hz keyed by a square-wave signal with a frequency of 50 Hz simulating a continuous dot pattern. Phase coherent switching between B-state and Y-state is preferable.

6.7.2 Standard test signal No. 2

Standard test signal No. 2 for VHF DSC watchkeeping receiver shall be a phase modulated signal as VHF channel 70 with modulation index equal to. The modulating signal shall have a centre frequency of 1 700 Hz and a frequency shift of ±400 Hz and be keyed with a square wave signal. Phase coherent switching between B-state and Y-state is preferable.

6.8 Measurement of bit error ratio

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

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

6.9 Measurement uncertainty and interpretation of the measuring results

6.9.1 Measurement uncertainty

Table 1

Absolute measurement uncertainties:	maximum values
RF frequency:	$\pm 1 \times 10^{-7}$
RF level:	±0,75 dB
Audio output power:	±0,5 dB
Sensitivity of receiver:	±3 dB
Conducted emission of receiver:	±3 dB
Two-signal measurement:	±4 dB
Three signal measurement:	±3 dB

For the test methods according to the present document the uncertainty figures are valid to a confidence level of 95 % calculated according to the methods described in ETR 028 [13].

6.9.2 Interpretation of measurement results

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

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

7 Environmental tests

7.1 Procedure

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

7.2 Performance check

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

- for MF band with standard test signal No. 1 applied at a level of +11 dBµV;
- for HF band with standard test signal No. 1 applied at a level of +6 dBµV;
- for VHF band with standard test signal No. 2 applied at a level of +6 dBµV.

The bit error ratio shall be less than 10^{-2}.

7.3 Vibration test

7.3.1 Definition

This test determines the ability of equipment to withstand vibration without resulting in mechanical weakness or degradation in performance.

7.3.2 Method of measurement

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

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

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

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

A resonance search shall be carried out throughout the test. If any resonance of the EUT has Q greater than or equal to 5 measured relative to the base of the vibration table, the EUT shall be subjected to a further endurance test at each resonant frequency at the vibration level specified in the test with a duration of 2 hours. If only resonance with Q less than 5 occurs this further endurance test shall be carried out at one of these resonant frequencies. If no resonance occurs, this further endurance test shall be carried out at a frequency of 30 Hz.

Performance check(s) (see subclause 7.2) shall be carried out before at the end of each two hour endurance test period.

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

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

7.3.3 Requirement

The equipment shall meet the requirements of the performance check.

There shall be no harmful deterioration of the equipment visible.

7.4 Temperature tests

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

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

7.4.1 Dry heat

7.4.1.1 Functional test (portable, protected and exposed equipment)

7.4.1.1.1 Definition

This test determines the ability of equipment to be operated at high ambient temperatures.

7.4.1.1.2 Method of measurement

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

At the end of a soak period of 10 hours to 16 hours at +55°C ± 3°C, the EUT shall be subjected to the performance test to subclause 7.2.

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

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

7.4.1.1.3 Requirement

The equipment shall meet the requirements of the performance check to subclause 7.2.

7.4.2 Damp heat

7.4.2.1 Definition

This test determines the ability of equipment to be operated under conditions of high humidity.

7.4.2.2 Method of measurement

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

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

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

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

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

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

7.4.2.3 Requirement

The equipment shall meet the requirements of the performance check to subclause 7.2.

7.4.3 Low temperature cycle

7.4.3.1 Definition

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

7.4.3.2 Method of measurement

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

The EUT shall be switched on 30 minutes later, or after such period as agreed by the manufacturer, and shall be operational for at least 2 hours during which period the EUT shall be subjected to the performance test to subclauses 8.2 or 9.2 as applicable.

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

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

7.4.3.3 Requirement

The equipment shall meet the requirements of the performance check to subclause 7.2.

7.5 Corrosion test

7.5.1 General

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

7.5.2 Definition

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

7.5.3 Method of measurement

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

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

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

At the conclusion of the test the EUT shall be inspected with the naked eye without magnification. there shall be no undue deterioration or corrosion of metal parts. The EUT shall then be subjected to the performance check.

7.5.4 Requirements

The equipment shall meet the requirements of the performance check to subclause 7.2.

8 MF/HF watchkeeping receiver

8.1 Calling sensitivity

8.1.1 Definition

The calling sensitivity of the receiver is a defined RF-signal level at which the bit error ratio at the output of the receiver is better than or equal to 10^{-2}.

8.1.2 Method of measurement

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

Standard test signal No. 1 shall be applied on the relevant frequencies in subclause 6.6.1:

- for MF the input level shall be +5 dBµV under normal and +11 dBµV under extreme test conditions; and
- for HF the input level shall be 0 dBµV under normal and +6 dBµV under extreme test conditions.

The bit error ratio in the output shall be determined as described in subclause 6.8.

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

For MF/HF equipment the test shall be repeated with test signal no.1 on the frequency specified in subclause 6.6.2, only under normal test conditions.

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

8.1.3 Limits

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

8.2 Adjacent channel selectivity

8.2.1 Definition

Adjacent channel selectivity is defined as the suppression of an unwanted signal, expressed as the bit error ratio caused by the unwanted signal in the output from the demodulator.

8.2.2 Method of measurement

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

The wanted RF signal shall be standard test signal No. 1 on the relevant frequencies specified in subclause 6.6.1 and the level of the wanted signal shall be 20 dBµV.

The level of the unwanted signal shall then be 60 dBµV.

The unwanted signal shall be an unmodulated signal at the frequency +500 Hz relative to the nominal frequency of the receiver (centre frequency).

The bit error ratio in the output shall be determined as described in subclause 6.8.

The measurement shall be repeated with the unwanted signal at a frequency -500 Hz relative to the nominal frequency of the receiver (centre frequency).

The bit error ratio in the output shall be determined as described in subclause 6.8.

8.2.3 Limits

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

8.3 Co-channel rejection

8.3.1 Definition

The co-channel rejection is the ability of the receiver to receive a wanted signal in the presence of an unwanted signal, both signals being on the wanted channel of the receiver.

8.3.2 Method of measurements

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

The wanted signal shall be standard test signal No. 1 on the relevant frequencies specified in subclause 6.6.1 and the level of the wanted signal shall be 20 dBµV.

The unwanted signal shall be unmodulated.

The level of the unwanted signal shall be 14 dBµV.

The bit error ratio in the output shall be determined as described in subclause 6.8.

8.3.3 Limits

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

8.4 RF intermodulation response

8.4.1 Definition

The RF intermodulation response is defined as the rejection of intermodulation products originating from two unwanted signals with given levels and frequencies, expressed as that level at which the bit error ratio is 10^{-2}.

8.4.2 Method of measurement

The signals applied to the receiver input shall be connected in accordance with subclause 6.5.

The wanted signal shall be standard test signal No. 1 on the relevant frequencies specified in subclause 6.6.1 and the level of the wanted signal shall be 20 dBµV.

The two unwanted signals are both unmodulated and at the same level. Neither of the two signals shall be at a frequency nearer to the wanted signal than 30 kHz (frequency combinations capable of resulting in unwanted intermodulation products are given in Recommendation ITU-R MS.332-4 [16]).

8.4.3 Limits

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

8.5 Spurious response rejection

8.5.1 Definition

The spurious response rejection is the ability of the receiver to discriminate between a wanted signal and unwanted signals with frequencies outside the passband of the receiver.

8.5.2 Method of measurement

The signals applied to the receiver input shall be connected in accordance with subclause 6.5.

The wanted signal shall be standard test signal No. 1 on the relevant frequencies specified in subclause 6.6.1 and the level of the wanted signal shall be 20 dBµV.

The bit error ratio in the output shall be determined as described in subclause 6.8.

Frequencies close to the nominal frequency:

- the input level of the unwanted signal shall be 60 dBµV for frequencies from +1 kHz to +3 kHz and from -1 kHz to -3 kHz relative to the nominal frequency.

Frequencies outside the range above:

- frequencies likely to cause spurious response are at the image frequencies of the mixers and at the various IF frequencies used in the receiver.

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

- the IF frequencies used;
- the local oscillator frequencies used;
- the coverage range;
- the pre first mixers filtering arrangements.

The coverage range is between 1 605 kHz and 4 000 kHz for MF receivers and between 1 606 kHz and 27,5 MHz for HF receivers.

NOTE: Measurements on F1B are only required if the receiver does not have the J3E mode.

The following tests shall be made:

- a complete search of the coverage range;
- a measurement of all IF frequencies outside the range;
- a measurement of all frequencies defined by:

$$n \times f_{lo1} \pm f_{if1}$$

$$p \times f_{receiv} \pm f_{if1}$$

$$(f_{lo2} +/- f_{if2}) \pm f_{lo1}$$

where n and p are integers and f_{lo1} is the local oscillator frequency of the first mixer, f_{if1} is the first IF frequency and f_{lo2} is the local oscillator frequency of the second mixer, f_{if2} is the second IF frequency.

The upper frequency of the test shall be 2 GHz.

Care should be taken when measuring IF rejection within the coverage range.

If the wanted signal frequency causes a filter to be introduced that improves the IF response, then another wanted frequency should be chosen in the same band as the IF frequency without being closer than 100 kHz of the IF frequency.

The receiver shall be set up in accordance with subclause 8.1. All receiver controls shall remain unaltered during the remainder of the test.

Two signal generators A and B shall be connected to the receiver input via a combining network so that they do not affect the impedance matching.

8.5.3 Limits

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

8.6 Dynamic range

8.6.1 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 receiver does not exceed a specified value.

8.6.2 Method of measurement

The signals applied to the receiver input shall be connected in accordance with subclause 6.5.

Standard test signal No. 1 on the relevant frequencies specified in subclause 6.6.1 shall be applied to the receiver input. The level of the RF signal shall be 80 dBµV.

The bit error ratio in the output shall be determined as described in subclause 6.8.

8.6.3 Limits

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

8.7 Conducted spurious emissions into the antenna

8.7.1 Definition

Conducted spurious emissions are all internally generated signals conducted to the antenna terminal.

8.7.2 Method of measurement

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

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

The bandwidth of the selective analyser shall be:

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

The detector shall be a peak detector.

8.7.3 Limits

The power of any spurious emission shall not exceed 2 nW.

8.8 Protection of receiver antenna input circuits

8.8.1 Definition

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

8.8.2 Method of measurement

The signals applied to the receiver input shall be connected in accordance with subclause 6.5.

An unmodulated radio frequency test signal at a level of 30 V r.m.s. at a single frequency in the range 100 kHz to 27,5 MHz is applied to the receiver antenna input for a period of 15 minutes.

8.8.3 Limits

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

8.9 Stop/start of scanning

8.9.1 Definition

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

8.9.2 Method of measurement

Two RF test signals with a level of 20 dBµV shall be applied to the receiver.

One of the RF signals shall have a nominal frequency corresponding to a frequency in the scanning sequence and shall be equal to standard test signal No. 1 modulated with a single DSC distress call.

The other RF signal shall have a nominal frequency corresponding to another frequency being scanned. It shall be equal to standard test signal No. 1 modulated with DSC calls with 20 dot pattern.

The distress call sequences shall be repeated after a random interval of 2,5 to 4,0 s.

The receiver shall be set to scan the maximum number of frequencies for which it is designed.

The number of transmitted distress calls shall be 200 and the symbol error rate shall be determined.

8.9.3 Limits

The total number of received distress calls shall be equal to or exceed 95 % of distress calls transmitted and the symbol error rate shall be less than or equal to 10^{-2}.

9 VHF watchkeeping receiver

9.1 Calling sensitivity

9.1.1 Definition

The calling sensitivity of the receiver is a defined RF-signal level at which the bit error ratio at the output of the receiver is better than or equal to 10^{-2}.

9.1.2 Method of measurement

The signals applied to the receiver input shall be connected in accordance with subclause 6.5.

Standard test signal No. 2 shall be applied to the receiver input.

The bit error ratio at the output shall be determined as described in subclause 6.8.

The input level shall be 0 dBµV under normal test conditions and +6 dBµV under extreme test conditions.

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

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

9.1.3 Limits

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

9.2 Adjacent channel selectivity

9.2.1 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 that differs in frequency from the wanted signal by 25 kHz.

9.2.2 Method of measurement

The signals applied to the receiver input shall be connected in accordance with subclause 6.5.

The wanted signal shall be standard test signal No. 2. The level of the wanted signal shall be +3 dBµV. The unwanted signal shall be modulated by 400 Hz with a deviation of ±3 kHz. The unwanted signal shall be tuned to the centre frequency of the upper adjacent channel.

The bit error ratio at the output of the receiver shall be determined as described in subclause 6.8.

The input level of the unwanted signal shall be 73 dBµV.

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

9.2.3 Limits

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

9.3 Co-channel rejection

9.3.1 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 nominal frequency of the receiver.

9.3.2 Method of measurement

The signals applied to the receiver input shall be connected in accordance with subclause 6.5.

The wanted signal shall be standard test signal No. 2. The level of the wanted signal shall be +3 dBµV. The unwanted signal shall be modulated by 400 Hz with a deviation of ±3 kHz. Both input signals shall be at the nominal frequency of the receiver under test and the measurement shall be repeated for displacements of the unwanted signal of up to ±3 kHz.

The bit error ratio at the output of the receiver shall be determined as described in subclause 6.8.

The input level of the unwanted signal shall be -5 dBµV.

9.3.3 Limits

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

9.4 Intermodulation response

9.4.1 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.

9.4.2 Method of measurement

The signals applied to the receiver input shall be connected in accordance with subclause 6.5.

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

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 ±3 kHz and adjusted to a frequency 100 kHz above (or below) the nominal frequency of the receiver.

The bit error ratio at the output of the receiver shall be determined as described in subclause 6.8.

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

9.4.3 Limits

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

9.5 Spurious response and blocking immunity

9.5.1 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 unmodulated signal with frequencies outside the passband of the receiver.

9.5.2 Method of measurement

The signals applied to the receiver input shall be connected in accordance with subclause 6.5.

The wanted signal shall be standard test signal No. 2. The level of the wanted signal shall be +3 dBμV.

For 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.

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

The bit error ratio at the output of the receiver shall be determined as described in subclause 6.8.

Where spurious responses occurs, the input level of the unwanted signal shall be 73 dBμV.

Where blocking occurs, the input level of the unwanted signal shall be 93 dBμV.

9.5.3 Limits

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

9.6 Dynamic range

9.6.1 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 receiver does not exceed a specified value.

9.6.2 Method of measurement

The signals applied to the receiver input shall be connected in accordance with subclause 6.5.

Standard test signal No. 2 shall be applied to the receiver input. The level of the test signal shall be 100 dBμV.

The bit error ratio at the output of the receiver shall be determined as described in subclause 6.8.

9.6.3 Limit

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

9.7 Conducted spurious emissions into the antenna

9.7.1 Definition

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

9.7.2 Method of measurement

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

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

The bandwidth of the selective analyser shall be:

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

The detector shall be a peak detector.

9.7.3 Limit

The power of any spurious emissions shall not exceed 2 nW.

History

Document history				
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