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**Maritime mobile transmitters and receivers
for use in the MF and HF bands;
Harmonised Standard covering the essential requirements
of articles 3.2 and 3.3(g) of Directive 2014/53/EU**

Reference

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ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
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Contents

Intellectual Property Rights	8
Foreword.....	8
Modal verbs terminology.....	8
1 Scope	9
2 References	9
2.1 Normative references	9
2.2 Informative references.....	10
3 Definitions, symbols and abbreviations	11
3.1 Definitions.....	11
3.2 Symbols.....	11
3.3 Abbreviations	12
4 General requirements	12
4.1 Environmental profile.....	12
4.2 General, operational and technical requirements.....	12
4.2.1 Testing of requirements	12
4.2.2 General requirements.....	12
4.2.2.1 Composition	12
4.2.2.1.1 DSC requirements	12
4.2.2.1.2 Audio frequencies interfaces	13
4.2.2.1.3 DSC Interface	13
4.2.2.1.4 Digital input panels.....	13
4.2.2.1.5 GNSS receiver antenna.....	13
4.2.2.2 Construction	13
4.2.2.3 Controls and indicators	14
4.2.2.3.1 General	14
4.2.2.3.2 Illumination	14
4.2.2.4 Labelling	14
4.2.2.4.1 General	14
4.2.2.4.2 Distress frequencies.....	14
4.2.2.5 Protection against mishandling	15
4.2.3 Operational requirements.....	15
4.2.3.1 Frequency bands	15
4.2.3.1.1 Operating bands.....	15
4.2.3.1.2 MF band	15
4.2.3.1.3 HF bands.....	15
4.2.3.2 Classes of emission	16
4.2.4 Warming up period	16
4.2.4.1 Time	16
4.2.4.2 Heaters	16
4.2.4.3 Heating circuits	16
4.2.4.4 Delay	16
4.2.5 Technical requirements.....	16
4.2.5.1 Distress controls	16
4.2.5.2 Telephony transmit control	16
4.2.5.3 Misuse	16
4.2.5.4 Control panel priority.....	17
4.2.5.5 Manual gain control and Automatic Gain Control (AGC).....	17
4.2.5.6 Output indication.....	17
4.2.5.7 DSC operation.....	17
4.2.5.8 Synthesizer lock	17
4.2.5.9 Channel switching.....	17
5 Test conditions, power sources and ambient temperatures	17
5.1 General	17
5.2 Test power source.....	17

5.3	Normal test conditions.....	18
5.3.1	Normal temperature and humidity	18
5.3.2	Normal test power source	18
5.3.2.1	Mains voltage and frequency	18
5.3.2.2	Secondary battery power sources	18
5.3.2.3	Other power sources.....	18
5.4	Extreme test conditions	18
5.4.1	Extreme temperature tests.....	18
5.4.2	Extreme values of test power source	18
5.4.2.1	Mains voltage and mains frequency	18
5.4.2.2	Secondary battery power sources	18
5.4.2.3	Other power sources.....	19
6	General conditions of measurement	19
6.1	Artificial antennas	19
6.1.1	Transmitters	19
6.1.2	Receivers	19
6.2	Standard test signals	19
6.2.1	Test signals applied to the receiver input.....	19
6.2.1.1	Sources	19
6.2.1.2	Levels	19
6.2.2	Normal test signals.....	20
6.2.2.1	General	20
6.2.2.2	Class of emission J3E.....	20
6.2.2.3	Class of emission F1B.....	20
6.2.3	Choice of testing frequencies.....	20
6.2.4	Exclusion bands for emissions testing	20
6.2.4.1	Transmitter exclusion bands.....	20
6.2.4.2	Receiver exclusion bands	20
6.2.5	Reference bandwidths for spurious measurements	20
7	Environmental tests	21
7.1	Introduction	21
7.2	Procedure.....	21
7.3	Performance check	21
7.4	Temperature tests	21
7.4.1	Definition	21
7.4.2	Dry heat	22
7.4.2.1	Method of measurement.....	22
7.4.2.1.1	Internally mounted equipment.....	22
7.4.2.1.2	Externally mounted equipment.....	22
7.4.2.2	Requirement.....	22
7.4.3	Damp heat	22
7.4.3.1	Method of measurement.....	22
7.4.3.2	Requirement	23
7.4.4	Low temperature cycle.....	23
7.4.4.1	Method of measurement.....	23
7.4.4.1.1	Internally mounted equipment.....	23
7.4.4.1.2	Externally mounted equipment.....	23
7.4.4.2	Requirement	23
7.5	Vibration test	23
7.5.1	Definition.....	23
7.5.2	Method of measurement	24
7.5.3	Requirements	24
7.6	Corrosion test	24
7.6.1	Applicability	24
7.6.2	Definition.....	24
7.6.3	Method of measurement	24
7.6.4	Requirements	25
7.7	Rain test.....	25
7.7.1	Applicability	25
7.7.2	Method of measurement	25

7.7.3	Requirements	26
8	Transmitter	26
8.1	Frequency error	26
8.1.1	Definition	26
8.1.2	Method of measurement	26
8.1.3	Limit	27
8.2	Output power and intermodulation products	27
8.2.1	Definition	27
8.2.2	Method of measurement	27
8.2.3	Limits	28
8.2.3.1	Output power in the range 1 606,5 kHz to 4 000 kHz for all modulation modes	28
8.2.3.2	Output power in the range 4 MHz to 27,5 MHz for all modulation modes	28
8.2.3.3	Intermodulation products for SSB telephony modes	28
8.2.3.4	Difference of power of B-state frequency and Y-state frequency	28
8.2.3.5	Output spectrum	29
8.3	Power of out-of-band emissions of SSB telephony	29
8.3.1	Definition	29
8.3.2	Method of measurement	29
8.3.3	Limits	30
8.4	Power of conducted spurious emissions of SSB telephony	30
8.4.1	Definition	30
8.4.2	Method of measurement	30
8.4.3	Limits	30
8.5	Carrier suppression	30
8.5.1	Definition	30
8.5.2	Method of measurement	31
8.5.3	Limit	31
8.6	Unwanted frequency modulation	31
8.6.1	Definition	31
8.6.2	Method of measurement	31
8.6.3	Limit	31
8.7	Sensitivity of the microphone and the 600 Ω line inputs for SSB telephony	31
8.7.1	Definition	31
8.7.2	Method of measurement	32
8.7.3	Limit	32
8.8	Automatic level control and/or limiter for SSB telephony	32
8.8.1	Definition	32
8.8.2	Method of measurement	32
8.8.3	Limit	33
8.9	Audio frequency response of SSB telephony	33
8.9.1	Definition	33
8.9.2	Method of measurement	33
8.9.3	Limit	33
8.10	Residual hum and noise power for telephony	34
8.10.1	Definition	34
8.10.2	Method of measurement	34
8.10.3	Limit	34
8.11	Residual frequency modulation on DSC	35
8.11.1	Definition	35
8.11.2	Method of measurement	35
8.11.3	Limit	35
8.12	Continuous operation on telephony	35
8.12.1	Definition	35
8.12.2	Method of measurement	35
8.12.3	Limits	35
8.13	Protection of transmitter	35
8.13.1	Definition	35
8.13.2	Method of measurement	36
8.13.3	Requirements	36
8.14	Transmitter radiated spurious emissions	36
8.14.1	Definition	36

8.14.2	Method of measurement	36
8.14.3	Limits.....	37
9	Receiver.....	37
9.1	Receiver spurious emissions.....	37
9.1.1	Definition.....	37
9.1.2	Method of measurement	37
9.1.2.1	Conducted antenna port measurement	37
9.1.2.2	Radiated measurement	37
9.1.3	Limits.....	38
9.2	Maximum usable sensitivity.....	38
9.2.1	Definition.....	38
9.2.2	Method of measurement	38
9.2.3	Limits.....	39
9.3	Adjacent signal selectivity.....	39
9.3.1	Definition.....	39
9.3.2	Method of measurement	39
9.3.3	Limits.....	40
9.4	Blocking or desensitization	40
9.4.1	Definition.....	40
9.4.2	Method of measurement	40
9.4.3	Limits.....	41
9.5	Intermodulation response	41
9.5.1	Definition.....	41
9.5.2	Method of measurement	41
9.5.2.1	Class of emission J3E.....	41
9.5.2.2	Class of emission F1B analogue	41
9.5.2.3	Class of Emission F1B digital	42
9.5.3	Limits.....	42
9.6	Spurious response rejection ratio.....	42
9.6.1	Definition.....	42
9.6.2	Method of measurement	42
9.6.3	Limits.....	43
9.7	Receiver frequency error	44
9.7.1	Definition.....	44
9.7.2	Method of measurement	44
9.7.3	Limit	44
9.8	Unwanted frequency modulation	44
9.8.1	Definition.....	44
9.8.2	Method of measurement	44
9.8.3	Limit	45
9.9	Pass band.....	45
9.9.1	Definition.....	45
9.9.2	Method of measurement	45
9.9.3	Limits.....	45
9.10	Reciprocal mixing	45
9.10.1	Definition.....	45
9.10.2	Method of measurement	45
9.10.3	Limit	46
9.11	Harmonic content in output	46
9.11.1	Definition.....	46
9.11.2	Method of measurement	46
9.11.3	Limits.....	46
9.12	Audio frequency intermodulation.....	46
9.12.1	Definition.....	46
9.12.2	Method of measurement	46
9.12.3	Limit	46
9.13	Internally generated spurious signals	47
9.13.1	Definition.....	47
9.13.2	Method of measurement	47
9.13.3	Limits.....	47
9.14	AGC efficiency	47

9.14.1	Definition	47
9.14.2	Method of measurement	47
9.14.2.1	General	47
9.14.2.2	Settings	47
9.14.2.3	Increase in Signal-to-Noise Ratio (SNR)	47
9.14.3	Limits	47
9.15	AGC time constants (attack and recovery time)	48
9.15.1	Definition	48
9.15.2	Method of measurement	48
9.15.3	Limits	48
9.16	Protection of input circuits	48
9.16.1	Definition	48
9.16.2	Method of measurement	48
9.16.3	Requirement	48
10	Testing for compliance with technical requirements	49
10.1	Environmental conditions for testing	49
10.2	Interpretation of the measurement results	49
Annex A (informative):	Relationship between the present document and the essential requirements of Directive 2014/53/EU	50
Annex B (informative):	Bibliography	52
Annex C (informative):	Change history	53
History		54

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Foreword

This draft Harmonised European Standard (EN) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM), and is now submitted for the combined Public Enquiry and Vote phase of the ETSI standards EN Approval Procedure.

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.12] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.1].

Once the present document is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of the present document given in tables A.1 and A.2 confers, within the limits of the scope of the present document, a presumption of conformity with the corresponding essential requirements of that Directive, and associated EFTA regulations.

The present document replaces ETSI EN 300 373-2 [i.10] and ETSI EN 300 373-3 [i.11].

National transposition dates	
Date of latest announcement of this EN (doa):	31 December 2017
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	30 June 2018
Date of withdrawal of any conflicting National Standard (dow):	30 June 2019

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the [ETSI Drafting Rules](#) (Verbal forms for the expression of provisions).

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1 Scope

The present document specifies technical characteristics and methods of measurements for radio transmitters and receivers, for use on vessels, operating in either the Medium Frequency (MF) only or in the Medium and High Frequency (MF/HF) bands allocated in the International Telecommunications Union (ITU) Radio Regulations [i.9], to the Maritime Mobile Service (MMS).

The present document refers to equipment for one or more of the following:

- Single SideBand (SSB) modulation for telephony transmission and reception (J3E);
- Frequency Shift Keying (FSK) or SSB modulation of a keyed sub-carrier to transmit and receive Digital Selective Calling (DSC) signals.

The present document also refers to radio equipment with either an integrated or external DSC controller.

The requirements in the present document are applicable to receivers for operating on all frequencies in the bands 1 606,5 kHz to 4 000 kHz or 1 606,5 kHz to 27,5 MHz as allocated in the ITU Radio Regulations [i.9], to the MMS.

Other spot frequency receivers should meet all the requirements of the present document and other relevant standards as applicable for the frequencies and modes provided.

If the equipment, or parts of it, are designed in such a manner that they can be used for other categories of maritime radiocommunication (e.g. Morse telegraphy or NBDP - ETSI ETS 300 067 [i.4]), those parts of the equipment should fulfil the relevant requirements of the appropriate standards for the service(s) in question e.g. ETSI ETS 300 067 [i.4].

The present document covers the essential requirements of article 3.2 and article 3.3(g) of Directive 2014/53/EU [i.1] under the conditions identified in annex A.

2 References

2.1 Normative references

References are specific, identified by date of publication and/or edition number or version number. Only the cited version applies.

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The following referenced documents are necessary for the application of the present document.

- [1] ETSI TS 103 052 (V1.1.1) (03-2011): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Radiated measurement methods and general arrangements for test sites up to 100 GHz".
- [2] ITU Recommendation E.161 (02-2001): "Arrangement of digits, letters and symbols on telephones and other devices that can be used for gaining access to a telephone network".
- [3] ETSI EN 300 338-4 (V1.2.1) (02-2017): "Technical characteristics and methods of measurement for equipment for generation, transmission and reception of Digital Selective Calling (DSC) in the maritime MF, MF/HF and/or VHF mobile service; Part 4: Class E DSC".

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

- [i.1] Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC.
- [i.2] ETSI TR 100 028-1 (V1.4.1) (12-2001): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 1".
- [i.3] ETSI TR 100 028-2 (V1.4.1) (12-2001): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 2".
- [i.4] ETSI ETS 300 067 (11-1990): "Radio Equipment and Systems (RES); Radiotelex equipment operating in the maritime MF/HF service; Technical Characteristics and methods of measurement".
- [i.5] Recommendation ITU-R SM.332-4 (07-1978): "Selectivity of receivers".
- [i.6] Recommendation ITU-R SM.326-7 (11-1998): "Determination and measurement of the power of amplitude-modulated radio transmitters".
- [i.7] ISO 3791 (1976): "Office machines and data processing equipment - Keyboard layouts for numeric applications".
- [i.8] CENELEC EN 60945 (2002): "Maritime navigation and radiocommunication equipment and systems - General requirements - Methods of testing and required test results".
- [i.9] ITU Radio Regulations (2016).
- [i.10] ETSI EN 300 373-2 (V1.2.1) (12-2009): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Maritime mobile transmitters and receivers for use in the MF and HF bands; Part 2: Harmonized EN covering essential requirements under article 3.2 of the R&TTE Directive".
- [i.11] ETSI EN 300 373-3 (V1.2.1) (12-2009): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Maritime mobile transmitters and receivers for use in the MF and HF bands; Part 3: Harmonized EN covering essential requirements under article 3.3(e) of the R&TTE Directive; Equipment with integrated or associated equipment for Class E Digital Selective Calling (DSC)".
- [i.12] Commission Implementing Decision C(2015) 5376 final of 4.8.2015 on a standardisation request to the European Committee for Electrotechnical Standardisation and to the European Telecommunications Standards Institute as regards radio equipment in support of Directive 2014/53/EU of the European Parliament and of the Council.
- [i.13] CENELEC EN 60945 4th edition (2002): "Maritime navigation and radiocommunication equipment and systems - General requirements - Methods of testing and required test results".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document the following terms and definitions apply:

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

carrier frequency: frequency to which the transmitter or receiver is tuned

environmental profile: range of environmental conditions under which equipment within the scope of the present document is required to comply with the provisions of the present document

spurious emission: emission 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

NOTE: Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products but exclude out-of-band emissions (ITU Radio Regulations [i.9]).

standard output power: output power of the receiver measured across a resistor equal to the nominal value of the load impedance as declared by the manufacturer

NOTE: Standard output power is 1 mW for earphone reception, 500 mW for loudspeaker reception and 0 dBm into 600 Ω for the audio line outputs.

3.2 Symbols

For the purposes of the present document, the symbols given in the ITU Radio Regulations [i.9] and the following apply:

dB	decibel
dBm	dBmilliwatt
dB μ V	dBmicrovolt
F1B	frequency modulation, single channel containing quantized or digital information without the use of a modulating sub-carrier, telegraphy for automatic reception
g	gram
h	hour
Hz	hertz
J2B	SSB, suppressed carrier, single channel containing quantized or digital information with the use of a modulating sub-carrier, telegraphy for automatic reception
J3E	SSB, suppressed carrier, single channel containing analogue information, telephony
k	kilo
kHz	kilohertz
kPa	kilopascal
l	litre
m	meter
MHz	megahertz
min	minute
mm	millimeter
ms	millisecond
mW	milliwatt
NaCl	sodium chloride
Ω	ohm
pF	picofarad
s	second
V	volt
W	watt

3.3 Abbreviations

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

AGC	Automatic Gain Control
BER	Bit Error Rate
CSP	Channel Spacing
DC	Direct Current
DSC	Digital Selective Calling
emf	electromotive force
EN	European Norm
EUT	Equipment Under Test
FM	Frequency Modulation
FSK	Frequency Shift Keying
GNSS	Global Navigation Satellite System
ISO	International Standards Organization
ITU	International Telecommunications Union
MF	Medium Frequency
MF/HF	Medium and High Frequency
MMS	Maritime Mobile Service
NBDP	Narrowband Direct Printing
PEP	Peak Envelope Power
RBW	Reference BandWidth
RF	Radio Frequency
RMS	Root Mean Square
SINAD	Signal plus Noise plus Distortion to Noise plus Distortion
SNR	Signal-to-Noise Ratio
SSB	Single Side Band

4 General requirements

4.1 Environmental profile

The technical requirements of the present document apply under the environmental profile for operation of the equipment, which shall be declared by the manufacturer, but as a minimum, shall be that specified in the test conditions contained in the present document. The equipment shall comply with all the technical requirements of the present document which are identified as applicable in annex A at all times when operating within the boundary limits of the declared operational environmental profile.

4.2 General, operational and technical requirements

4.2.1 Testing of requirements

There are no defined tests for the requirements in clause 4.2. The availability of the specified controls shall be verified by visual inspection.

4.2.2 General requirements

4.2.2.1 Composition

4.2.2.1.1 DSC requirements

The equipment shall contain either:

- a dedicated watchkeeping receiver for the DSC decoder;

- a DSC encoder;
- a DSC decoder; and
- an integral GNSS receiver providing locating function;

Or:

- a dedicated DSC controller interface as specified in clause 4.2.2.1.3.

4.2.2.1.2 Audio frequencies interfaces

The following inputs and outputs applicable to the type of equipment shall be provided:

- a) transmitters:
 - SSB Telephony:
 - 600 Ω earth free audio input;
 - microphone input;
- b) receivers:
 - SSB Telephony:
 - 600 Ω earth free audio output;
 - earphone output;
 - speaker output.

Audio processing may be applied to audio outputs for handset, external speaker, etc., but shall not affect line level audio interfaces. Where audio processing is activated it shall be assessed. The acoustic speech recognition is equal to, or better than without audio processing enabled under receive conditions at sensitivity level.

4.2.2.1.3 DSC Interface

If the equipment does not have an integrated DSC controller then, the equipment shall have a dedicated interface for an external DSC controller compliant with ETSI EN 300 338-4 [3].

Other interfaces than those described in this clause may be provided but shall not in any case have an impact which will degrade the performance of the equipment.

4.2.2.1.4 Digital input panels

Where a digital input panel with the digits "0" to "9" is provided, the digits shall be arranged to conform to one of the options described in clause 3 of Recommendation ITU-T E.161 [2]. However, where an alphanumeric keyboard layout is provided, the digits "0" to "9" may, alternatively, be arranged to conform to ISO 3791 [i.7].

4.2.2.1.5 GNSS receiver antenna

The integrated GNSS receiver shall have the possibility to connect an external antenna.

4.2.2.2 Construction

The attention of the manufacturer is drawn to CENELEC EN 60945 [i.8] which offers guidelines on the construction and ergonomic details for equipment intended to be used on board vessels.

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

Adequately detailed operating instructions shall be provided with the equipment.

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

4.2.2.3 Controls and indicators

4.2.2.3.1 General

All controls shall be easily identified from the position at which the operator operates the equipment.

The number of operational controls, their design and manner of functioning, location, arrangement and size should provide for simple, quick and efficient operation. Controls which are not necessary for normal operation shall not be readily accessible to the operator.

The controls should be arranged in a manner which minimizes the risk of inadvertent operation.

For transmitters it shall be possible to change the transmitter from any class of emission to another for which it is designed to operate by means of not more than one control.

For receivers the class of emission shall be selectable by not more than one control.

Facilities shall be provided to enable the loudspeaker to be switched off when reception is by headphones or telephone handset. Automatic facilities shall be provided to turn off the loudspeaker during duplex operation.

If a device is provided in the receiver to reduce the effects of impulsive noise, a switch shall be provided to disable its function.

4.2.2.3.2 Illumination

Equipment intended to be installed on the navigating bridge of a ship shall be provided with adequate illumination to enable identification of controls and facilitate reading of indicators at all times. Means shall be provided for reducing continuously, to extinction, the output of any light source on the equipment which is capable of interfering with navigation.

All adjustments and controls necessary for switching the transmitter and receiver to operate on the distress and safety channels covered by the equipment shall be clearly marked in order that this operation can be easily performed.

If the accessible controls are located on a separate control panel and if there are two or more control panels, one of the control panels shall have priority over the others. If there are two or more control panels, when any control panel is in use, this shall be clearly indicated on all of the other control panels.

4.2.2.4 Labelling

4.2.2.4.1 General

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

The compass safe distance shall be stated on the equipment or in the user document.

4.2.2.4.2 Distress frequencies

The distress frequencies shown in table 1, which are applicable to the equipment, shall be clearly indicated, either on the front panel of the equipment or on an instruction label supplied with the equipment.

Table 1: Distress frequencies

DSC (kHz)	Telephony (kHz)	Telex (kHz)
2 187,5	2 182	2 174,5
4 207,5	4 125	4 177,5
6 312	6 215	6 268
8 414,5	8 291	8 376,5
12 577	12 290	12 520
16 804,5	16 420	16 695
NOTE: The above DSC and telex frequencies are assigned frequencies whereas the carrier frequency is indicated for telephony.		

In addition, manual controls necessary for the tuning of the equipment to the relevant frequencies in table 1, and their settings, shall be clearly indicated.

4.2.2.5 Protection against mishandling

Provision shall be made for protecting the equipment from damage if the power supply is subject to transient voltage changes, from damage due to the accidental reversal of the polarity of the power supply, and from the effects of excessive voltage.

The information in any volatile memory device shall be protected from interruptions in the power supply up to 60 s duration. The information in programmable memory devices and the vessel's identity and information inherent to the DSC process shall be stored in non-volatile memory devices.

The information in user programmable memory devices shall be protected from interruptions in the power supply of at least 10 h duration.

4.2.3 Operational requirements

4.2.3.1 Frequency bands

4.2.3.1.1 Operating bands

The equipment shall be capable of operating in either the MF or in the MF/HF bands as defined in clauses 4.2.3.1.2 and 4.2.3.1.3.

4.2.3.1.2 MF band

The equipment shall provide for the transmission and/or reception in the appropriate frequency bands between 1 606,5 kHz and 4 000 kHz allocated in the ITU Radio Regulations [i.9] to the MMS.

4.2.3.1.3 HF bands

The equipment shall provide for the transmission and/or reception in the appropriate frequency bands between 4 MHz and 27,5 MHz allocated in the ITU Radio Regulations [i.9] to the MMS.

4.2.3.2 Classes of emission

The equipment shall provide for the transmission and/or reception of signals using the classes of emission defined below, as appropriate to the equipment:

- | | |
|-----|--|
| J3E | SSB telephony, with the carrier suppressed at least 40 dB below peak envelope power; |
| F1B | FSK suitable for DSC with a frequency shift of ± 85 Hz. Alternatively class of modulation J2B can be used with a 1 700 Hz sub-carrier. In this case the equipment shall be tuned to a carrier frequency 1 700 Hz below the assigned frequency. |

The receiver may also provide for the reception of signals of other classes of emission.

4.2.4 Warming up period

4.2.4.1 Time

The equipment shall be operational and shall meet the requirements of the present document one minute after switching on, except as provided in clause 4.2.4.2.

4.2.4.2 Heaters

If the equipment includes parts which require to be heated in order to operate correctly, (e.g. crystal ovens), then a warming-up period of 30 min from the instant of application of power to those parts shall be allowed, after which the requirements of the present document shall be met.

4.2.4.3 Heating circuits

Where clause 4.2.4.2 is applicable, the power supplies to the heating circuits shall be arranged so that they can remain operative when other supplies to the equipment or within the equipment are switched off. If a special switch for these circuits is provided on the equipment, the function of the switch shall be clearly indicated and the operating instructions shall state that the circuit should normally be left connected to the power supply source.

A visual indication that power is connected to such circuits shall be provided.

4.2.4.4 Delay

If it is necessary to delay the application of power to any part of the transmitter after switching on, such delay shall be provided automatically.

4.2.5 Technical requirements

4.2.5.1 Distress controls

All adjustments and controls necessary for switching the transmitter and receiver to operate on the distress and safety channels covered by the equipment shall be clearly marked in order that this operation can be easily performed.

4.2.5.2 Telephony transmit control

In single or two-frequency simplex operating mode, switching from the receiving condition to the transmitting condition and vice versa, shall be accomplished by a single control. This control should be located on the microphone or telephone handset and when at rest shall leave the equipment in the receive condition.

4.2.5.3 Misuse

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

4.2.5.4 Control panel priority

If the accessible controls are located on a separate control panel and if there are two or more control panels, one of the control panels shall have priority over the others. If there are two or more control panels, when any control panel is in use, this shall be clearly indicated on all of the other control panels.

4.2.5.5 Manual gain control and Automatic Gain Control (AGC)

Telephony receivers shall be provided with a manual control of audio frequency gain and with an AGC of the radio frequency and/or intermediate frequency capable of operation on the classes of emission specified in clause 4.2.3.2 and the frequency ranges specified in clause 4.2.3.1.

4.2.5.6 Output indication

The transmitter shall incorporate an indicator of the antenna current and/or output power.

4.2.5.7 DSC operation

The radio shall have either an integrated DSC controller or a dedicated interface for an external DSC controller.

In either case the operation of the DSC controller and radio combination shall comply with all the requirements of ETSI EN 300 338-4 [3] for Class E DSC.

4.2.5.8 Synthesizer lock

It shall not be possible to transmit until any frequency synthesizer, used to obtain the frequency set on the control panel or front of the transmitter, is locked.

4.2.5.9 Channel switching

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

Operation of the transmit/receive control shall not cause unwanted emissions.

5 Test conditions, power sources and ambient temperatures

5.1 General

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

When preparing test report forms for equipment tested in accordance with the present document, the point where the DC voltage is measured shall be specified (see clause 5.2).

5.2 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 clauses 5.3.2 and 5.4.2.

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.

5.3 Normal test conditions

5.3.1 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 %.

5.3.2 Normal test power source

5.3.2.1 Mains voltage and frequency

The normal test voltage for equipment to be connected to the ac mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage or any one of the declared voltages for which the equipment was designed.

The frequency of the test power supply corresponding to the ac mains shall be 50 Hz \pm 1 Hz.

5.3.2.2 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.).

5.3.2.3 Other power sources

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

5.4 Extreme test conditions

5.4.1 Extreme temperature tests

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

Before making measurements, the equipment shall have reached thermal balance in the test chamber. The equipment shall be switched off during the temperature stabilizing period, except the power supplies to the heating circuits. 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.

5.4.2 Extreme values of test power source

5.4.2.1 Mains voltage and mains frequency

The extreme test voltages for equipment to be connected to an ac mains supply shall be the nominal mains voltage \pm 10 %.

The frequency of the test power supply corresponding to the ac mains shall be 50 Hz \pm 1 Hz.

5.4.2.2 Secondary battery power sources

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

5.4.2.3 Other power sources

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

6 General conditions of measurement

6.1 Artificial antennas

6.1.1 Transmitters

For the purpose of conformance testing, the transmitter, at the output of the antenna matching device, shall meet the requirements of the present document when connected to the artificial antennas listed below:

- frequency range 1 606,5 kHz to 4 000 kHz:
 - the artificial antenna shall consist of a resistance of 10 Ω and a capacitance of 250 pF connected in series;
- frequency range 4 MHz to 27,5 MHz:
 - the artificial antenna shall consist of a non reactive, non radiating 50 Ω load.

These characteristics shall in no way imply that the transmitter shall only work with antennas having these characteristics.

6.1.2 Receivers

For the purpose of conformance testing, the receiver shall meet the requirements of the present document when connected to a test source, as described in clause 6.2.1.1, at the point at which the antenna is normally connected, having the following characteristics:

- the test signal shall be derived from a resistive source of 50 Ω except as permitted below:
 - in the frequency range 1 606,5 kHz to 4 000 kHz at the request of the manufacturer, an artificial antenna consisting of a 10 Ω resistor in series with a 250 pF capacitor may be used for frequencies below 4 MHz.

The arrangement used shall be stated in the test report.

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

6.2 Standard test signals

6.2.1 Test signals applied to the receiver input

6.2.1.1 Sources

Sources of test signals for application to the receiver input shall be connected through a network such that the impedance presented to the receiver input is equal to that of the artificial antennas specified in clause 6.1.2. 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.

6.2.1.2 Levels

The levels of test input signals shall be expressed in terms of the emf which would exist at the output terminals of the source including the associated network referred to in clause 6.1.2.

6.2.2 Normal test signals

6.2.2.1 General

Except where otherwise stated, radio frequency test signals applied to the receiver input shall be as described in the clauses 6.2.2.2 and 6.2.2.3.

6.2.2.2 Class of emission J3E

Unmodulated signal, 1 000 Hz ($\pm 0,1$ Hz) above the carrier frequency to which the receiver is tuned.

6.2.2.3 Class of emission F1B

DSC with an analogue interface, unmodulated signal on the assigned frequency.

DSC with a digital interface, a signal on the assigned frequency, modulated as appropriate.

Frequency shift signal with ± 85 Hz shift at 100 Bd with pseudo random bit pattern.

6.2.3 Choice of testing frequencies

Unless otherwise stated, tests shall be carried out at the distress frequency (see table 1) and one other frequency for that class of emission in each of the bands in which the equipment is designed to operate.

The frequencies used shall be stated in the test report.

6.2.4 Exclusion bands for emissions testing

6.2.4.1 Transmitter exclusion bands

Frequencies ± 12 kHz of the assigned frequency shall be excluded from test.

For stand-alone transmitters in the transmitter stand-by mode, frequencies within the centre frequency f_c and $f_c + 2,7$ kHz shall be excluded from test.

6.2.4.2 Receiver exclusion bands

None applicable.

6.2.5 Reference bandwidths for spurious measurements

The reference bandwidths applicable for all spurious measurement are given in tables 2 and 3.

Table 2: Reference bandwidths to be used for the measurement of spurious emissions

Frequency range	RBW
9 kHz to 150 kHz	1 kHz
150 kHz to 30 MHz	10 kHz
30 MHz to 1 GHz	100 kHz
Above 1 GHz	1 MHz

Table 3: Reference bandwidths to be used close to the wanted emission for equipment operating below 1 GHz

Frequency offset from carrier	RBW
250 % of the CSP to 100 kHz	1 kHz
100 kHz to 500 kHz	10 kHz

7 Environmental tests

7.1 Introduction

The equipment shall be capable of continuous operation under the conditions of various sea states, vibration, humidity and change of temperature likely to be experienced in a ship in which it is installed.

7.2 Procedure

Environmental tests shall be carried out before tests of the same equipment in respect to the other requirements of the present document are performed.

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.

During the environmental tests, the output of the transmitter may be reduced by 6 dB, but shall exceed 60 W PEP.

7.3 Performance check

For the purpose of the present document, the term "performance check" shall be taken to mean the following measurements and limits:

- for the transmitter:

- frequency error:

With the transmitter connected to an artificial antenna (see clause 6.1.1), the transmitter shall be tuned to the frequency 2 182 kHz for MF equipment or 8 291 kHz for MF/HF equipment and operated in J3E mode and shall be modulated with a signal of 1 000 Hz \pm 0,1 Hz. The 1 000 Hz signal shall be subtracted from the measured frequency to get the transmitter frequency. The transmitter frequency shall be within \pm 10 Hz of the selected frequency.

- output power:

With the transmitter connected to an artificial antenna (see clause 6.1.1), the transmitter shall be tuned to the frequency 2 182 kHz for MF equipment or 8 291 kHz for MF/HF equipment and operated in J3E mode. The transmitter shall be modulated by a test signal consisting of two audio frequency tones, applied simultaneously to the microphone input, at frequencies of 1 100 Hz and 1 700 Hz. The level of the tones shall be adjusted so that they produce equal output power and it shall be possible to obtain an output power of greater than 60 W PEP.

- for the receiver:

- maximum usable sensitivity.

With the AGC operative, the receiver shall be adjusted to 2 182 kHz for MF equipment or 8 291 kHz for MF/HF equipment and operated in J3E mode. A test signal as specified in clause 6.2.1 shall be applied. The level of the input signal shall be adjusted until the SINAD at the output of the receiver is 20 dB, and the output power is at least the standard output power (see clause 3.1). The level of the input signal shall be not greater than +22 dB μ V at 2 182 kHz or not greater than +17dB μ V at 8 291 kHz.

7.4 Temperature tests

7.4.1 Definition

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

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

7.4.2 Dry heat

7.4.2.1 Method of measurement

7.4.2.1.1 Internally mounted equipment

The equipment shall be placed in a chamber at normal room temperature. The temperature shall then be raised to, and maintained at, +55 °C (± 3 °C) for a period of at least 10 h.

After this period any climatic control device provided in the equipment may be switched on.

30 min later, the equipment shall be switched on, and shall then be kept working continuously for a period of 2 h.

The equipment shall be subjected to a performance check during the 2 h period.

At the end of the test, and with the equipment still in the chamber, the chamber shall be brought to room temperature in not less than 1 h. The equipment shall then be exposed to normal room temperature and humidity for not less than 3 h before the next test is carried out.

7.4.2.1.2 Externally mounted equipment

The equipment shall be placed in a chamber at normal room temperature. The temperature shall be raised to and maintained at +70 °C (± 3 °C) for a period of at least 10 h.

After this period any climatic control device provided in the equipment may be switched on and the chamber cooled to +55 °C (± 3 °C). The cooling of the chamber shall be completed within 30 min.

The equipment shall then be switched on and shall be kept working continuously for a period of 2 h.

The equipment shall be subjected to a performance check during the 2 h period.

The temperature of the chamber shall be maintained at +55 °C (± 3 °C) during the 2 h period.

At the end of the test, and with the equipment still in the chamber, the chamber shall be brought to room temperature in not less than 1 h. The equipment shall then be exposed to normal room temperature and humidity for not less than 3 h before the next test is carried out.

7.4.2.2 Requirement

The requirement for the performance check as defined in clause 7.3 shall be met.

7.4.3 Damp heat

7.4.3.1 Method of measurement

The equipment shall be placed in a chamber at normal room temperature and humidity which, steadily, over a period of 3 h ($\pm 0,5$ h), shall be heated from room temperature to +40 °C (± 3 °C) and shall during this period be brought to a relative humidity of 93 % (± 2 %) so that excessive condensation is avoided.

These conditions shall be maintained for a period of at least 10 h.

After this period, any climatic control devices provided within the equipment may be switched on.

30 min later the equipment shall be switched on, and shall then be kept working continuously for a period of 2 h.

The equipment shall be subjected to a performance check during the 2 hour period.

The temperature and the relative humidity of the chamber shall be maintained at +40 °C (± 3 °C) and 93 % (± 2 %) during the 2 h 30 min period.

At the end of the test, and with the equipment still in the chamber, the chamber shall be brought to room temperature in not less than 1 h. The equipment shall then be exposed to normal room temperature and humidity for not less than 3 h, or until moisture has dispersed, whichever is longer, before the next test is carried out.

7.4.3.2 Requirement

The requirement for the performance check as defined in clause 7.3 shall be met.

7.4.4 Low temperature cycle

7.4.4.1 Method of measurement

7.4.4.1.1 Internally mounted equipment

The equipment shall be placed in a chamber at normal room temperature. The temperature shall then be reduced to, and maintained at, $-15\text{ °C} (\pm 3\text{ °C})$ for a period of at least 10 h.

After this period, any climatic control devices and/or heat sources provided in the equipment may be switched on.

The equipment shall then be subjected to a performance check lasting no more than 30 min.

The temperature of the chamber shall be maintained at $-15\text{ °C} (\pm 3\text{ °C})$ during the performance check.

At the end of the test, and with the equipment still in the chamber, the chamber shall be brought to room temperature in not less than 1 h. The equipment shall then be exposed to normal room temperature for not less than 3 h, or until moisture has dispersed, whichever is longer, before the next test is carried out.

7.4.4.1.2 Externally mounted equipment

The equipment shall be placed in a chamber at normal room temperature. The temperature shall then be reduced to, and maintained at, $-30\text{ °C} (\pm 3\text{ °C})$ for a period of at least 10 h.

Any climatic control devices provided in the equipment may then be switched on and the chamber warmed to $-20\text{ °C} (\pm 3\text{ °C})$. The warming of the chamber shall be completed within 30 min (± 5 min).

The temperature of the chamber shall then be maintained at $-20\text{ °C} (\pm 3\text{ °C})$ during a period of 1 h 30 min.

The equipment shall be subjected to a performance check during the last 30 min of the test. Any heat sources for the equipment may be switched on during the performance check.

At the end of the test, and with the equipment still in the chamber, the chamber shall be brought to room temperature in not less than 1 h. The temperature shall then be exposed to normal room temperature for not less than 3 h, or until moisture has dispersed, whichever is longer, before the next test is carried out.

Throughout the test the equipment shall be working normally.

7.4.4.2 Requirement

The requirement for the performance check as defined in clause 7.3 shall be met.

7.5 Vibration test

7.5.1 Definition

The immunity against the effects of vibration is the ability of the equipment to maintain the specified mechanical and electrical performance when the following test is carried out.

7.5.2 Method of measurement

The equipment, complete with any shock absorbers which are part of it, shall be clamped to the vibration table by its normal means of support and in its normal attitude.

The equipment may be suspended to compensate for weight not capable of being withstood by the vibration table.

Provisions may be made to reduce or nullify any adverse effect on the equipment performance which may be caused by the presence of any electro-magnetic fields from the vibration table.

Taking at least 15 min to cover each octave of frequency, the equipment shall be subjected to sinusoidal vertical vibration at all frequencies between:

- 2 Hz or 5 Hz and 13,2 Hz with an excursion of $\pm 1 \text{ mm} \pm 10 \%$;
- 13,2 Hz and 100 Hz with a constant maximum acceleration of 7 m/s/s.

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

The test shall be repeated with vibration in each of the mutual perpendicular direction in the horizontal plane.

A performance check shall be carried out at least once during each endurance test period and once before the end of each endurance test period.

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

It is recommended to perform the tests described in clauses 8.6 and 9.8 during this test.

7.5.3 Requirements

The test shall not cause the equipment to activate or operate spuriously.

The requirement for the performance check as defined in clause 7.3 shall be met. No damage or mechanical deterioration shall be visible to the naked eye. The EUT if tested with a vibration absorber (e.g. a life jacket) shall not become detached.

7.6 Corrosion test

7.6.1 Applicability

This test may be excluded if sufficient evidence is provided that the corresponding requirements of this clause are met.

7.6.2 Definition

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

7.6.3 Method of measurement

The equipment shall be placed in a chamber fitted with apparatus capable of spraying in the form of a fine mist a salt solution to the following formula:

- sodium chloride 26,50 g $\pm 10 \%$;
- magnesium chloride 2,50 g $\pm 10 \%$;
- magnesium sulphate 3,50 g $\pm 10 \%$;

- calcium chloride 1,10 g \pm 10 %;
- potassium chloride 0,73 g \pm 10 %;
- sodium bicarbonate 0,20 g \pm 10 %;
- sodium bromide 0,28 g \pm 10 %;
- plus distilled water to make the solution up to 1 l.

Alternatively a 5 % sodium chloride (NaCl) solution may be used.

The salt used for the test shall be high quality sodium chloride (NaCl) containing, when dry, not more than 0,1 % sodium iodide and not more than 0,3 % of total impurities.

Salt solution concentration shall be 5 % (\pm 1 %) by weight.

The solution shall be prepared by dissolving, by weight, 5 parts \pm 1 part of salt in 95 parts of distilled or de-mineralized water.

The pH value of the solution shall be between 6,5 and 7,2 at temperature of 20 °C (\pm 2 °C). The pH value shall be maintained within this range during conditioning; for this purpose, diluted hydrochloric acid or sodium hydroxide may be used to adjust the pH value, provided that the concentration of NaCl remains within the prescribed limits. The pH value shall be measured when preparing each new batch of solution.

The spraying apparatus shall be such that the products of corrosion cannot mix with the salt solution contained within the spray reservoir.

The equipment shall be sprayed simultaneously on all its external surfaces with the salt solution for a period of 1 h.

This spraying shall be carried out four times with a storage period of 7 days at 40 °C (\pm 2 °C) after each spraying. The relative humidity during storage shall be maintained between 90 % and 95 %.

At the end of the total period the equipment shall be examined visually.

7.6.4 Requirements

There shall be no undue deterioration or corrosion of the metal parts, finishes, material, or component parts visible to the naked eye.

In the case of hermetically sealed equipment there shall be no evidence of moisture penetration.

The requirement for the performance check as defined in clause 7.3 shall be met.

7.7 Rain test

7.7.1 Applicability

The test shall only be performed for equipment intended to be mounted above deck.

7.7.2 Method of measurement

The equipment shall be placed in an appropriate measurement chamber.

Throughout the test the equipment shall be working normally.

The test shall be carried out by spraying the equipment from all practicable directions with a stream of water from a hose.

The conditions to be observed are as follows:

- internal diameter of the nozzle: 12,5 mm;
- delivery rate: 100 l/min ($\pm 5\%$);
- water pressure at the nozzle: approximately 100 kPa (1 bar). The pressure shall be adjusted to achieve the specified delivery rate. At 100 kPa the water shall rise freely for a vertical distance of approximately 8 m above the nozzle;
- test duration: 30 min;
- distance from the nozzle to the equipment surface: approximately 3 m.

At the end of the test the equipment shall be subjected to a performance check and inspected.

Following inspection, the equipment shall be resealed in accordance with the manufacturer's instructions.

7.7.3 Requirements

No damage shall be visible to the naked eye and the equipment shall not show any sign of significant external damage or harmful penetration of water, and the requirements of the performance check as defined in clause 7.3 shall be met.

8 Transmitter

8.1 Frequency error

8.1.1 Definition

The frequency error of the transmitter is defined as:

- a) for SSB telephony:
 - the difference between the measured frequency less 1 000 Hz and the nominal value of the frequency for the particular telephony channel;
- b) for DSC with an analogue interface:
 - the difference between the measured and the nominal assigned frequency;
- c) for DSC with a digital interface:
 - the difference between the measured Y-state frequency and the nominal assigned frequency -85 Hz and the difference between the measured B-state frequency and the nominal assigned frequency +85 Hz.

8.1.2 Method of measurement

The frequency shall be measured with the transmitter connected to an artificial antenna (see clause 6.1.1).

Measurement shall be made under normal test conditions (see clause 5.3) and under extreme test conditions (clauses 5.4.1 and 5.4.2 applied simultaneously).

- a) SSB telephony:
 - the transmitter shall be modulated with a signal of 1 000 Hz $\pm 0,1$ Hz. The 1 000 Hz signal shall be subtracted from the measured frequency to get the transmitter frequency.
- b) DSC with an analogue interface:
 - the transmitter shall be modulated with a signal of 1 700 Hz $\pm 0,1$ Hz.

c) DSC with a digital interface:

- the digital input shall first be connected to a digital 0 and then to a digital 1.

8.1.3 Limit

The transmitter frequencies shall, after the warming-up period specified in clause 4.2.4 be within ± 10 Hz of the frequencies calculated in accordance with the definitions in clause 8.1.1.

8.2 Output power and intermodulation products

8.2.1 Definition

The output power is the value of peak envelope power delivered by the transmitter to the artificial antenna in telephony SSB mode or the value of the mean power delivered by the transmitter to the artificial antenna in DSC mode.

NOTE: The measurement of intermodulation products characterizes the linearity of amplitude modulated transmitters and is defined in Recommendation ITU-R SM.326-7 [i.6].

8.2.2 Method of measurement

The transmitter shall be connected to the appropriate artificial antenna as specified in clause 6.1.1.

Operating frequencies shall be 2 182 kHz and each of the distress frequencies in bands 4 MHz, 6 MHz, 8 MHz, 12 MHz, 16 MHz and on one frequency in the highest band of operation as appropriate to the equipment.

a) For SSB telephony:

- the transmitter shall be modulated by a test signal consisting of two audio frequency tones, applied simultaneously to the microphone input, at frequencies of 1 100 Hz and 1 700 Hz. The level of the tones shall be adjusted so that they produce equal output power. The level of the input test signal shall be increased until the transmitter power output is the rated output power as declared by the manufacturer $\pm 1,5$ dB. The level of the input signal shall then be increased by 10 dB;
- the peak envelope power and the intermodulation products shall be measured;
- the input signal shall then be decreased by 20 dB, and measurement of the intermodulation products is repeated;
- the test shall be repeated using the 600 Ω audio line input connections provided.

b) For DSC with an analogue interface:

- the transmitter shall be modulated by a generator producing a continuous dot pattern first at 0 dBm at 600 Ω and then at +10 dBm at 600 Ω . The mean power and the difference between the power of the Y-state frequency and the power of the B-state frequency shall be measured, and the output spectrum recorded.

c) For DSC with a digital interface:

- the transmitter shall be modulated by a generator producing a continuous dot pattern. The mean power and the difference between the power of the Y-state frequency and the power of the B-state frequency shall be measured, and the output spectrum recorded.

The tests shall be performed under both normal (see clause 5.3) and extreme test conditions (see clauses 5.4.1 and 5.4.2 applied simultaneously).

8.2.3 Limits

8.2.3.1 Output power in the range 1 606,5 kHz to 4 000 kHz for all modulation modes

The maximum peak envelope power (J3E) or maximum mean power (F1B) (see clause 8.2), shall be within $\pm 1,5$ dB of the manufacturer's declared rated output power and shall be greater than 60 W and shall not exceed 400 W regardless of any measurement uncertainty applicable.

8.2.3.2 Output power in the range 4 MHz to 27,5 MHz for all modulation modes

The maximum peak envelope power (J3E) or maximum mean power (F1B), (see clause 8.2), shall be within $\pm 1,5$ dB of the manufacturer's declared rated output power and shall be greater than 60 W, and shall not exceed 1 500 W regardless of any measurement uncertainty applicable.

8.2.3.3 Intermodulation products for SSB telephony modes

For equipment with a rated output power exceeding 250 W PEP the value of intermodulation products shall not exceed 25 dB below the highest of the two tones under normal test conditions and shall not exceed 22 dB below the highest of the two tones under extreme test conditions.

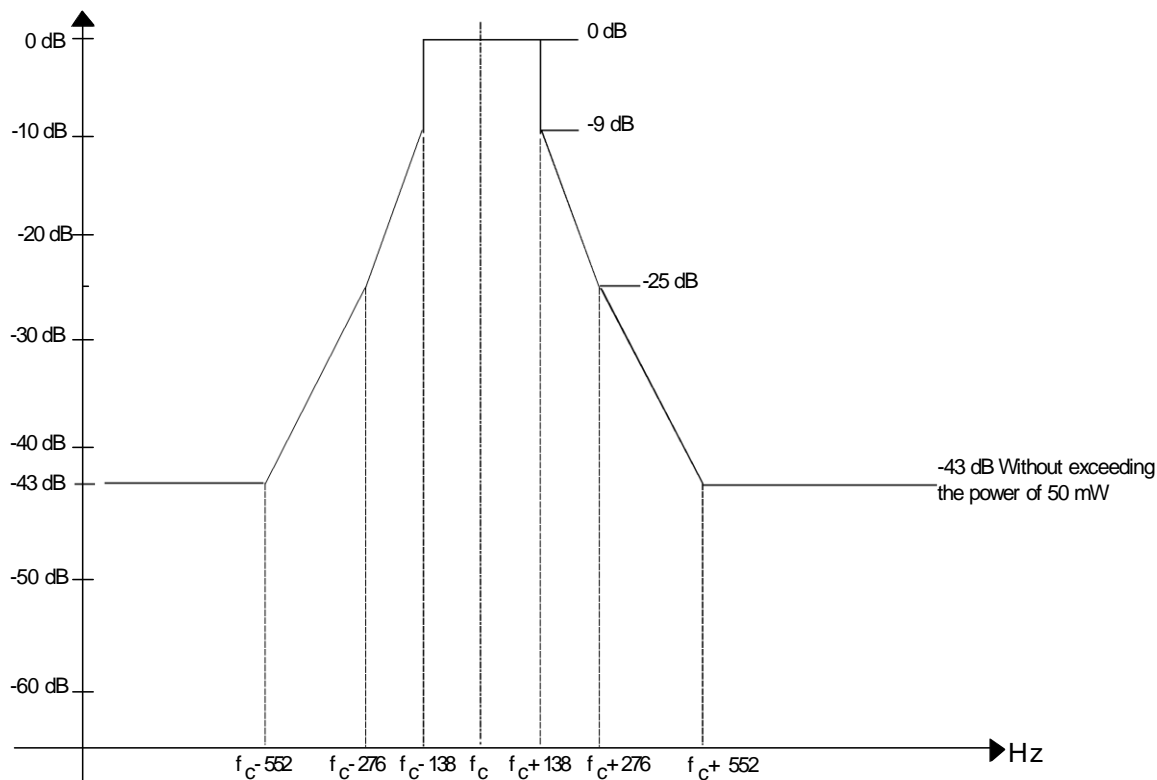
For equipment with a rated output power up to and including 250 W PEP the value of intermodulation products shall not exceed 22 dB below the highest of the two tones under normal test conditions and shall not exceed 19 dB below the highest of the two tones under extreme test conditions.

8.2.3.4 Difference of power of B-state frequency and Y-state frequency

The difference of the power of the B-state frequency and the Y-state frequency shall not exceed 2 dB.

8.2.3.5 Output spectrum

The output spectrum on DSC sending a dot pattern shall fall within the mask defined in figure 1.



f_c : centre frequency.

Figure 1: Output spectrum

8.3 Power of out-of-band emissions of SSB telephony

8.3.1 Definition

Out-of-band emissions are emissions on a frequency or frequencies immediately outside the necessary bandwidth which result from the modulation process, but excluding spurious emissions.

8.3.2 Method of measurement

The transmitter shall be connected to the appropriate artificial antenna as specified in clause 6.1.1 and driven to the maximum output power measured in clause 8.2 by a modulating signal consisting of two audio-frequency tones with a frequency separation between them such that all intermodulation products occur at frequencies at least 1 500 Hz removed from a frequency 1 400 Hz above the carrier.

The test shall be carried out using the microphone input and the 600 Ω audio line input.

Any limiter or automatic control of the modulation level shall be in normal operation.

8.3.3 Limits

The power of any out-of-band emission supplied to the artificial antenna shall be in accordance with the limits given in table 4.

Table 4: Limits for out-of-band emissions

Separation Δ in kHz between the frequency of the out-of-band emission and a frequency 1 400 Hz above the carrier	Minimum attenuation below maximum peak envelope power
$1,5 < \Delta \leq 4,5$	31 dB
$4,5 < \Delta \leq 7,5$	38 dB
$7,5 < \Delta \leq 12$	43 dB without exceeding the power of 50 mW

8.4 Power of conducted spurious emissions of SSB telephony

8.4.1 Definition

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.

8.4.2 Method of measurement

The transmitter shall be connected to a 50 Ω power attenuator. The modulation input shall be terminated by a 600 Ω termination, and the transmitter shall be placed in the transmit mode.

The spurious emissions shall be measured from 9 kHz to 4 GHz.

The measurements are performed excluding transmit exclusion band centred on the frequency on which the transmitter is intended to operate (see clauses 4.2.3.1 and 6.2.4.1).

The resolution bandwidth of the measuring receiver should be equal to the reference bandwidth as given in clause 6.2.5.

Any limiter or automatic control of the modulation level shall be in normal operation.

For stand-alone transmitters this test shall be repeated in the transmitter stand-by mode. The frequencies within the centre frequency f_c and $f_c + 2,7$ kHz shall be excluded from this transmitter test.

8.4.3 Limits

The power of any conducted spurious emission at the antenna port shall be in accordance with table 5.

Table 5: Limits for spurious emissions

Frequency range	Minimum attenuation below peak envelope power in Tx mode	Power in the Tx standby mode
9 kHz to 2 GHz	43 dB without exceeding the power of 50 mW	2 nW
> 2 GHz to 4 GHz	43 dB without exceeding the power of 50 mW	20 nW

8.5 Carrier suppression

8.5.1 Definition

The carrier suppression is expressed in terms of the ratio between the peak envelope power and the carrier power output power.

8.5.2 Method of measurement

The transmitter shall be connected to the appropriate artificial antenna described in clause 6.1.1. It shall then be modulated by an audio frequency of 1 000 Hz to produce the maximum output power as measured in clause 8.2.

The carrier suppression shall be measured in J3E mode.

The test shall be performed under both normal (see clause 5.3) and extreme test conditions (see clauses 5.4.1 and 5.4.2 applied simultaneously).

8.5.3 Limit

The carrier suppression for modulation J3E shall be at least 40 dB.

8.6 Unwanted frequency modulation

8.6.1 Definition

Unwanted frequency modulation is the deviation of output frequency of the transmitter which may occur due to a number of causes but especially when the complete equipment is vibrated over a specified range of frequencies and amplitudes.

8.6.2 Method of measurement

The transmitter complete with chassis covers and shock absorbers (if supplied) shall be clamped in its normal operating position to a vibrating table and shall be connected to the appropriate artificial antenna as specified in clause 6.1.1.

The transmitter shall then be switched on, adjusted for the transmission of class of emission J3E and, after the warming-up period permitted under clause 4.2.4, shall be modulated by means of a test signal consisting of an audio frequency tone applied to the modulation input at a frequency of 1 000 Hz for SSB telephony or 1 700 Hz for DSC.

The level of the input test signal shall be adjusted to such a level that the output power is 3 dB below the result of the power measurement in clause 8.2.

Any frequency deviation shall be measured by means of a monitoring receiver using a suitable, calibrated, FM demodulator or frequency deviation meter. The deviation meter bandwidth shall be ± 125 Hz. The table shall be vibrated as detailed in clause 7.5.2.

The test shall be performed on 2 182 kHz if the transmitter is designed to work in the 1 606,5 kHz to 4 000 kHz band only or on a frequency in the 8 MHz band if the equipment is designed to work on all maritime bands in the 1 606,5 kHz to 27 500 kHz range.

8.6.3 Limit

The frequency peak deviation shall not exceed ± 5 Hz.

8.7 Sensitivity of the microphone and the 600 Ω line inputs for SSB telephony

8.7.1 Definition

This test shows the capability of the transmitter to produce its full output power, and be fully modulated, when an acoustic tone signal corresponding to the normal mean speech level is applied to the microphone supplied with the equipment or when a normal audio line signal level is applied to the 600 Ω line input.

8.7.2 Method of measurement

An acoustic tone at a frequency of 1 000 Hz and a sound level of 94 dBA shall be applied to the microphone and the output power measured.

An audio tone with a frequency of 1 000 Hz and a level of -16 dBm shall be applied to the 600 Ω line input terminals and the output power measured. The transmitter shall be tuned to the frequency 2 182 kHz for MF equipment or 8 291 kHz for MF/HF equipment.

8.7.3 Limit

The output power level shall be within -3 dB and -9 dB relative to the maximum output power as measured in clause 8.2.

8.8 Automatic level control and/or limiter for SSB telephony

8.8.1 Definition

This test shows the capability of the equipment to produce an output power, proportional with the modulating input power.

8.8.2 Method of measurement

The transmitter shall be tuned to the frequency 2 182 kHz for MF equipment or 8 291 kHz for MF/HF equipment.

The transmitter shall be connected to the appropriate artificial antenna as specified in clause 6.1.1 and modulated to within 0 dB and -1 dB of the maximum output power as measured in clause 8.2, by a test signal consisting of four audio-frequency tones of equal amplitude, applied to the modulation input, at frequencies of 700 Hz, 1 100 Hz, 1 700 Hz and 2 500 Hz.

Where the level of the test signal is so low as to make its measurement impractical, it is permissible to employ a calibrated attenuator having a characteristic impedance equal to the transmitter input impedance as declared by the manufacturer. The input level to the transmitter may then be calculated from measurements of signal level at the input to the attenuator and the value of attenuation in circuit.

The level of the test signal shall be varied and the peak voltage of the input signal, together with the corresponding values of peak envelope power shall be measured at a sufficient number of points for a graph of input level against peak envelope power to be plotted. The graph shall be placed in figure 2 in such a way that it touches the upper limits at two points at least, without exceeding the upper limits anywhere.

The input signal level corresponding to -10 dB relative to rated output power shall be recorded.

The test shall be repeated using the 600 Ω audio line input.

8.8.3 Limit

The graph shall lie within the limits given in figure 2.

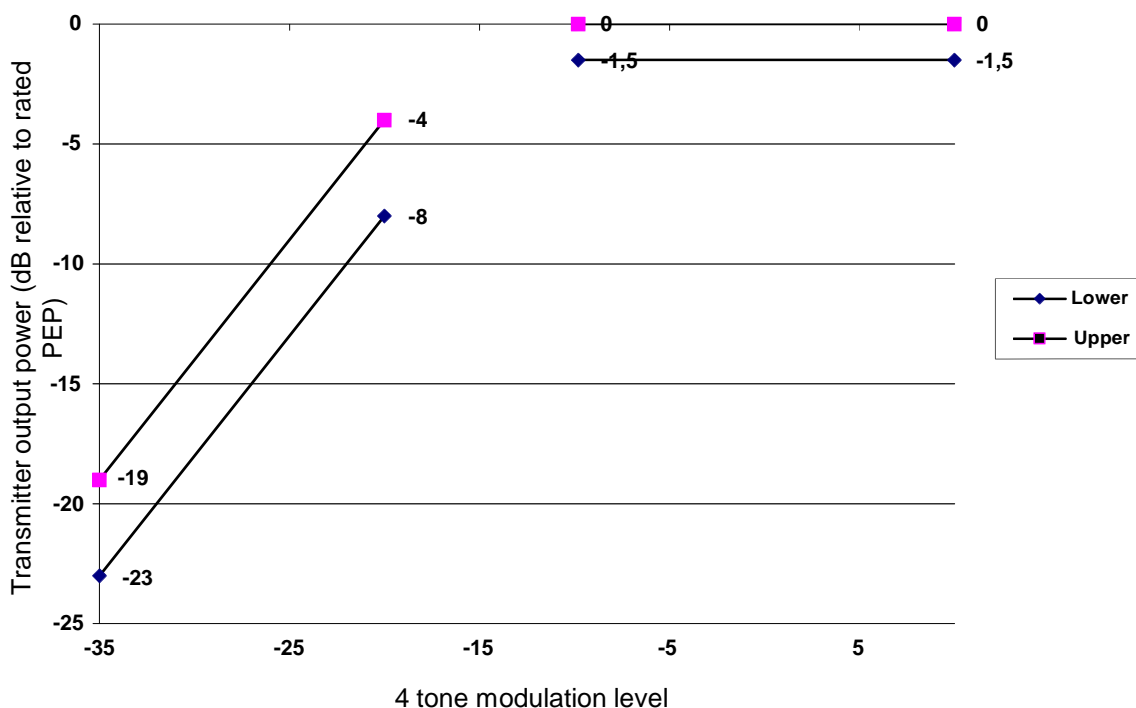


Figure 2: Limits of telephony level control

8.9 Audio frequency response of SSB telephony

8.9.1 Definition

The audio frequency response is the variation of the output power as a function of the modulation audio frequency.

8.9.2 Method of measurement

The transmitter shall be tuned to the frequency 2 182 kHz for MF equipment or 8 291 kHz for MF/HF equipment.

The transmitter shall be connected to the appropriate artificial antenna described in clause 6.1.1 and modulated by a sinusoidal audio frequency test signal connected to the modulation input. The frequency of the test signal shall then be varied between 100 Hz and 10 kHz. The resulting radio frequency power shall be measured at the output of the transmitter using a selective method (e.g. spectrum analyser).

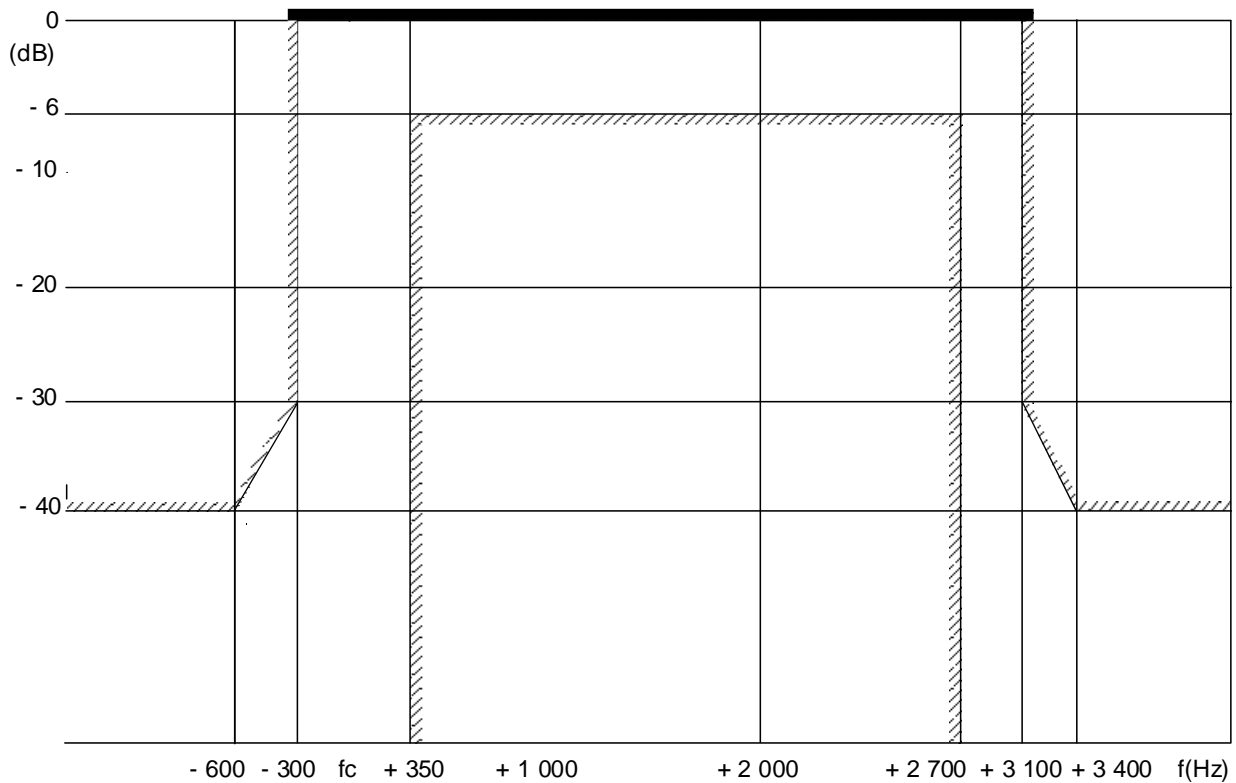
The level of the test signal shall be adjusted so that the output power at the peak of the response characteristic is 10 dB below the rated output power.

The frequency response characteristic obtained shall be adjusted so that its peak touches the 0 dB line shown in figure 3.

The test shall be repeated using the 600 Ω audio line input.

8.9.3 Limit

The audio frequency response characteristic and its image shall lie between the hatched areas shown in figure 3.



Audio frequency response

Figure 3: Limits of audio frequency response

8.10 Residual hum and noise power for telephony

8.10.1 Definition

The residual hum and noise power is that power supplied by the transmitter to the artificial antenna when the modulation input signals are interrupted.

8.10.2 Method of measurement

The transmitter shall be tuned to the frequency 2 182 kHz for MF equipment or 8 291 kHz for MF/HF equipment.

The transmitter shall be connected to the appropriate artificial antenna described in clause 6.1.1. It shall then be modulated by a two-tone test signal to produce the maximum output power as measured in clause 8.2.

The test signal shall then be disconnected from the transmitter modulation input terminals and the radio frequency power shall be measured at the transmitter output within a frequency band which lies between the carrier frequency and 2 700 Hz above the carrier frequency.

The modulation input circuit terminals shall then be short-circuited and the radio frequency power shall be measured again. This test shall be repeated using the 600 Ω audio line input.

8.10.3 Limit

The total residual hum and noise power excluding the carrier shall be at least 40 dB below the peak envelope power.

8.11 Residual frequency modulation on DSC

8.11.1 Definition

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

8.11.2 Method of measurement

The transmitter shall be connected to the appropriate artificial antenna described in clause 6.1.1. It shall then be modulated by a dot pattern to produce the maximum output power as measured in clause 8.2.

The RF output terminal of the equipment shall be fed to a suitable, calibrated, FM demodulator. The output of the demodulator shall be limited in bandwidth by a low-pass filter with a cut-off frequency of 1 kHz and a slope of 12 dB/octave. DC voltages shall be suppressed by an ac coupling device so that they do not influence the result of the measurement.

The RMS output level shall be measured during continuous transmission of the B or Y signal and during the transmission of continuous dot pattern.

The ratio of the two measured RMS output levels from the demodulator shall be determined.

8.11.3 Limit

The residual frequency modulation shall not be greater than -26 dB.

8.12 Continuous operation on telephony

8.12.1 Definition

Continuous operation of the transmitter is the ability to produce full rated RF output power without interruption for a specified time.

8.12.2 Method of measurement

The transmitter shall be connected to the artificial antenna as specified in clause 6.1.1 and driven to its maximum output power measured under clause 8.2 using the two-tone test signal as described in that clause. The equipment shall transmit continuously for a period of 15 min.

The transmitter shall be tuned to the frequency 2 182 kHz for MF equipment or 8 291 kHz for MF/HF equipment.

The measurement shall be carried out under normal (see clause 5.3) and extreme test conditions (see clauses 5.4.1 and 5.4.2 applied simultaneously).

8.12.3 Limits

The output power shall remain within the limits specified in either clause 8.2.3.1 or 8.2.3.2 as applicable to the operating frequency band.

8.13 Protection of transmitter

8.13.1 Definition

This represents the protection afforded to the transmitter against damage which may be caused by faults occurring in the ship's transmitting antenna.

8.13.2 Method of measurement

After the transmitter has been tuned and whilst the transmitter is being driven to the rated output power by the simultaneous application of two modulating signals of equal level, the antenna terminals shall first be short-circuited and then open-circuited, in each case for a period of 5 min. This test shall be conducted on one frequency only. The frequency chosen shall be recorded in the test report.

NOTE: Due to the nature of this test it would be prudent to perform a safety review of the planned implementation prior to performing the test especially at the higher RF power involved.

8.13.3 Requirements

This test shall not result in any damage to the transmitter. After removal of the short-circuit or open-circuit conditions, the transmitter shall be able to operate normally for all available modes.

8.14 Transmitter radiated spurious emissions

8.14.1 Definition

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.

8.14.2 Method of measurement

On a test site, selected from clause 5 of ETSI TS 103 052 [1], the equipment shall be placed at the specified height on a non-conducting support.

The transmitter antenna connector shall be connected to an artificial antenna (see clause 6.1.1).

The output of the test antenna shall be connected to a measuring receiver.

The test antenna shall be orientated for vertical polarization and the length of the test antenna shall be chosen to correspond to the instantaneous frequency of the measuring receiver.

The transmitter shall be tuned to the frequency 2 182 kHz for MF equipment or 8 291 kHz for MF/HF equipment.

The transmitter shall be modulated with same test signal as used in clause 8.2 and the measurements made over the frequency range 30 MHz to 2 GHz.

The measurements are performed excluding transmit exclusion band centred on the frequency on which the transmitter is intended to operate (see clauses 4.2.3.1 and 6.2.4.1).

The resolution bandwidth of the measuring receiver should be equal to the reference bandwidth as given in clause 6.2.5.

The transmitter shall be switched on and the measuring receiver shall be tuned over the frequency range 30 MHz to 2 GHz. At each frequency at which a discrete spurious component is detected, the test antenna shall be raised and lowered through the specified range of heights until a maximum signal level is detected on the measuring receiver.

The transmitter shall then be rotated through 360 ° in the horizontal plane, until the maximum signal level is detected by the measuring receiver.

The measuring receiver shall measure the mean power and this power shall be noted. The horizontal and vertical orientation of the antenna shall also be noted.

The transmitter shall be replaced by a substitution antenna as defined in clause 5.3.2 of ETSI TS 103 052 [1].

The substitution antenna shall be orientated for vertical polarization and the length of the substitution antenna shall be adjusted to correspond to the frequency of the spurious component detected.

The substitution antenna shall be connected to a calibrated signal generator.

The frequency of the calibrated signal generator shall be set to the frequency of the spurious component detected.

The input attenuator setting of the measuring receiver shall be adjusted in order to increase the sensitivity of the measuring receiver, if necessary.

The test antenna shall be raised and lowered through the specified range of heights to ensure that the maximum signal is received.

The input signal to the substitution antenna shall be adjusted to the level that produced a level detected by the measuring receiver, that is equal to the level noted while the spurious component was measured, corrected for the change of input attenuator setting of the measuring receiver.

The input level to the substitution antenna shall be recorded as power level.

The measurement shall be repeated with the test antenna and the substitution antenna orientated for horizontal polarization.

The measure of the effective radiated power of the spurious components is the larger of the two power levels recorded for each spurious component at the input to the substitution antenna, corrected for the gain of the antenna if necessary.

The measurement shall be repeated with the transmitter in the "stand-by" position.

8.14.3 Limits

The power of any spurious emission, occurring outside the exclusion band centred on the frequency on which the transmitter is intended to operate, shall not exceed the values given in table 5 of clause 8.4.3.

9 Receiver

9.1 Receiver spurious emissions

9.1.1 Definition

Spurious emissions are any radio frequency emissions generated in the receiver and radiated either by way of conduction to the antenna or other conductors connected to the receiver, or radiated directly by the receiver.

9.1.2 Method of measurement

9.1.2.1 Conducted antenna port measurement

The receiver antenna port shall be terminated into 50 Ω and a search shall be made for the presence of signals appearing across the resistor. The measurement shall be made over the frequency range 9 kHz to 4 GHz.

The resolution bandwidth of the measuring receiver should be equal to the reference bandwidth as given in clause 6.2.5.

9.1.2.2 Radiated measurement

On a test site, selected from clause 5 of ETSI TS 103 052 [1], the equipment shall be placed at the specified height on a non-conducting support.

The receiver antenna connector shall be connected to an artificial antenna (see clause 6.1.2).

The output of the test antenna shall be connected to a measuring receiver.

The test antenna shall be orientated for vertical polarization and the length of the test antenna shall be chosen to correspond to the instantaneous frequency of the measuring receiver.

The resolution bandwidth of the measuring receiver should be equal to the reference bandwidth as given in clause 6.2.5.

The equipment shall be switched on in receive mode and the measuring receiver shall be tuned over the frequency range 30 MHz to 2 GHz. At each frequency at which a discrete spurious component is detected, the test antenna shall be raised and lowered through the specified range of heights until a maximum signal level is detected on the measuring receiver.

The equipment shall then be rotated through 360 ° in the horizontal plane, until the maximum signal level is detected by the measuring receiver.

The measuring receiver shall measure the mean power and this power shall be noted. The horizontal and vertical orientation of the antenna shall also be noted.

The equipment shall be replaced by a substitution antenna as defined in clause 5.3.2 of ETSI TS 103 052 [1].

The substitution antenna shall be orientated for vertical polarization and the length of the substitution antenna shall be adjusted to correspond to the frequency of the spurious component detected.

The substitution antenna shall be connected to a calibrated signal generator.

The frequency of the calibrated signal generator shall be set to the frequency of the spurious component detected.

The input attenuator setting of the measuring receiver shall be adjusted in order to increase the sensitivity of the measuring receiver, if necessary.

The test antenna shall be raised and lowered through the specified range of heights to ensure that the maximum signal is received.

The input signal to the substitution antenna shall be adjusted to the level that produced a level detected by the measuring receiver, that is equal to the level noted while the spurious component was measured, corrected for the change of input attenuator setting of the measuring receiver.

The input level to the substitution antenna shall be recorded as power level.

The measurement shall be repeated with the test antenna and the substitution antenna orientated for horizontal polarization.

The measure of the effective radiated power of the spurious components is the larger of the two power levels recorded for each spurious component at the input to the substitution antenna, corrected for the gain of the antenna if necessary.

9.1.3 Limits

The power of any discrete component measured into 50 Ω shall not exceed 2 nW from 9 kHz to 2 GHz and 20 nW from 2 GHz to 4 GHz. In the frequency band 156,000 MHz to 165,000 MHz the limit is reduced to 200 pW (this is equivalent to the 30 dB μV/m specified in CENELEC EN 60945 [i.8]).

9.2 Maximum usable sensitivity

9.2.1 Definition

The maximum usable sensitivity is the minimum level of a radio frequency input signal with specified modulation which will produce at the receiver analogue outputs a chosen value of Signal + Noise + Distortion/Noise + Distortion (SINAD) ratio and, at the same time an output power not less than the standard output power.

In the case of digital outputs it is the minimum level of a radio frequency input signal with specified modulation which will produce a chosen value of bit error ratio.

9.2.2 Method of measurement

With the AGC operative, tests shall be carried out with the receiver adjusted for each frequency range and class of emission for which it is designed. The test input signal to the receiver shall be the normal test signals specified in clause 6.2.2.

For each test the input level of the test signal shall be adjusted until the SINAD ratio at the receiver output is 20 dB or the bit error ratio is less than 10^{-2} and at the same time at least the standard output power or levels are obtained. The measured input level is the maximum usable sensitivity. Where a bit error ratio test is carried out the tests shall be repeated with the input signal ± 10 Hz of its nominal value.

Measurement shall be made under normal test conditions (see clause 5.3) and under extreme test conditions (see clauses 5.4.1 and 5.4.2 applied simultaneously).

9.2.3 Limits

The maximum usable sensitivity shall be better than the values given in table 6.

Table 6: Limits of maximum usable sensitivity

Frequency range	Class of emission	Maximum level of input of input signal (dB μ V) 50 Ω or 10 Ω and 250 pF source impedance	
		Normal conditions	Extreme conditions
1 606,5 kHz to 4 000 kHz	J3E	+16	+22
	F1B	+5	+11
4 MHz to 27,5 MHz	J3E	+11	+17
	F1B	+0	+6

9.3 Adjacent signal selectivity

9.3.1 Definition

Adjacent signal selectivity is defined as the ability of the receiver to discriminate between a wanted signal (to which the receiver is tuned) and unwanted signals existing simultaneously in channels adjacent to that of the wanted signal or an increase of the bit error ratio to 10^{-2} .

9.3.2 Method of measurement

The arrangements for applying two test signals to the receiver input shall be according to clause 6.2.1. The AGC shall be in operation.

The wanted signal shall be in accordance with clause 6.2.2.

Class of emission J3E and Class of emission F1B (analogue output)

Analogue receivers shall be adjusted to give standard output power on the wanted frequency, and to give a SINAD ratio, of 20 dB.

The level of the unwanted signal shall be increased (starting from a low level), until the SINAD ratio, is decreased from 20 dB to 14 dB or the bit error ratio decreases to 10^{-2} .

Class of emission F1B (digital output)

NOTE: Measurement on F1B is only required if the receiver does not have the J3E mode.

The wanted signal level shall be 20 dB μ V, and shall be modulated with the sequence from a BER generator. The unwanted signal shall have a level of +60 dB μ V and be unmodulated.

Digital receivers shall have a bit error ratio of better than 10^{-2} .

The wanted signal level shall be +20 dB μ V.

9.3.3 Limits

The adjacent signal selectivity shall exceed the values given in tables 7, 8 and 9.

Table 7: Class of emission J3E

Carrier frequency of unwanted signal relative to carrier frequency of wanted signal	Adjacent signal selectivity
-1 kHz and +4 kHz	40 dB
-2 kHz and +5 kHz	50 dB
-5 kHz and +8 kHz	60 dB

Table 8: Class of emission F1B

Carrier frequency of unwanted signal relative to carrier frequency of wanted signal	Adjacent signal selectivity
-500 Hz and +500 Hz	40 dB

Table 9: Class of emission F1B (digital output)

Carrier frequency of unwanted signal relative to carrier frequency of wanted signal	Adjacent signal selectivity
-500 Hz and +500 Hz	BER = 10^{-2} or better

9.4 Blocking or desensitization

9.4.1 Definition

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

9.4.2 Method of measurement

The tests shall be carried out in J3E with the AGC operative, the RF/IF gain control (if provided) at its maximum, and any input attenuator adjusted to minimum attenuation. The measurements shall be made by means of the simultaneous application of two test signals to the input of the receiver. One of the test signals is the wanted signal to which the receiver is tuned, and the other is the unwanted signal.

Class of emission J3E or F1B (analogue output)

Measurements shall be carried out with an input level of the wanted signal of +60 dB μ V and repeated with the wanted signal at a level equal to the maximum usable sensitivity of the receiver as measured in clause 9.2.

The wanted test input signal to the receiver shall be the normal test signal specified in clause 6.2.2.

The receiver shall be adjusted so that the wanted signal gives standard output power.

The unwanted signal shall have a frequency of ± 20 kHz relative to that of the wanted signal.

The unwanted signal shall be unmodulated. The input level of the unwanted signal shall be adjusted until either it causes a change of 3 dB in the output level of the wanted signal, or until it causes a reduction of the SINAD ratio of 6 dB, whichever effect occurs first. The input level of the unwanted signal, when the specified condition is reached, shall be taken as the blocking level.

Class of emission F1B (digital output)

NOTE: Measurement on F1B is only required if the receiver does not have the J3E mode.

Measurements shall be carried out with an input level of the wanted signal of +60 dB μ V.

The unwanted signal shall be unmodulated. The input level of the unwanted signal shall be set to a level of +100 dB μ V.

9.4.3 Limits

Class of emission J3E or F1B (analogue output)

With the wanted signal at +60 dB μ V, the level of the unwanted signal shall be not less than 100 dB μ V.

With the wanted signal at a level equal to the measured maximum usable sensitivity, the level of the unwanted signal shall be at least +65 dB above the measured usable sensitivity level.

Class of emission F1B (digital output)

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

9.5 Intermodulation response

9.5.1 Definition

Intermodulation is a process by which signals are produced from two or more (generally unwanted) signals simultaneously present in a non-linear circuit.

9.5.2 Method of measurement

9.5.2.1 Class of emission J3E

With the AGC operative, the RF/IF gain control (if provided) at its maximum, and any input attenuator adjusted to minimum attenuation, an unmodulated input signal 1 000 Hz higher than the frequency to which the receiver is tuned shall be applied to the receiver input at a level of +30 dB μ V and the audio frequency gain control shall be adjusted to give standard output power.

With the wanted signal still applied, two equal level unmodulated signals shall be simultaneously applied to the input of the receiver, neither of these two signals shall have a frequency within 30 kHz from the wanted signal.

When choosing the frequencies used for this measurement, care should be taken to avoid frequencies at which spurious responses occur.

NOTE: Input frequencies likely to cause unwanted intermodulation products are described in Recommendation ITU-R SM.332-4 [i.5], section 6.4.

The input levels of the two interfering signals shall remain equal and shall be adjusted to reduce the SINAD ratio at the receiver output to 20 dB, carefully adjusting the frequency of one of the unwanted signals to maximize the reduction in SINAD ratio.

9.5.2.2 Class of emission F1B analogue

With the AGC operative, the RF/IF gain control (if provided) at its maximum, and any input attenuator adjusted to minimum attenuation, an unmodulated input signal on the assigned frequency shall be applied to the receiver input at a level of +20 dB μ V.

With the wanted signal still applied, two equal level unmodulated signals shall be simultaneously applied to the input of the receiver, neither of these two signals shall have a frequency within 30 kHz from the wanted signal.

When choosing the frequencies used for this measurement, care should be taken to avoid frequencies at which spurious responses occur.

NOTE: Input frequencies likely to cause unwanted intermodulation products are described in Recommendation ITU-R SM.332-4 [i.5], section 6.4.

The input levels of the two interfering signals shall remain equal and shall be adjusted to reduce the SINAD ratio at the receiver output to 20 dB, carefully adjusting the frequency of one of the unwanted signals to maximize the reduction in SINAD ratio.

9.5.2.3 Class of Emission F1B digital

With the AGC operative, the RF/IF gain control (if provided) at its maximum, and any input attenuator adjusted to minimum attenuation, a signal on the assigned frequency shall be applied to the receiver input at a level of +20 dB μ V, modulated with a signal of 100 baud with a frequency shift of ± 85 Hz suitable for bit error ratio tests.

Two equal level unmodulated signals shall be simultaneously applied to the input of the receiver, neither of these two signals shall have a frequency within 30 kHz from the wanted signal.

When choosing the frequencies used for this measurement, care should be taken to avoid frequencies at which spurious responses occur.

NOTE: Input frequencies likely to cause unwanted intermodulation products are mentioned in Recommendation ITU-R SM.332-4 [i.5], section 6.4.

The input levels of the two interfering signals shall remain equal and shall be adjusted to reduce the bit error ratio at the receiver output to 10^{-2} , carefully adjusting the frequency of one of the unwanted signals to maximize the reduction in bit error ratio.

9.5.3 Limits

The level of each of the two interfering signals which result in a 20 dB SINAD ratio at the receiver output shall be not less than +80 dB μ V for J3E and +70 dB μ V for analogue F1B.

The level of each of the two interfering signals which result in a bit error ratio of 10^{-2} for digital receivers shall be not less than +70 dB μ V.

9.6 Spurious response rejection ratio

9.6.1 Definition

The spurious response rejection ratio is the ratio of the input level of an unwanted signal, at the frequency of the spurious response to the input level of a wanted signal, when the wanted and unwanted signals individually produce the same SINAD ratio at the receiver output.

9.6.2 Method of measurement

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

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 mixer filtering arrangements.

Test should be made with a wanted frequency on 2 182 kHz for J3E receivers and 2 187,5 kHz for F1B receivers if the coverage is between 1 606,5 kHz and 4 000 kHz and 8 291 kHz for J3E receivers and 8 376,5 kHz for F1B receivers if the coverage is between 1 606,5 kHz and 27,5 MHz.

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 that range;
- a measurement of all frequencies defined by:
 - $n \times f_{lo1} \pm f_{if1}$;
 - $p \times f_{receive} \pm f_{if1}$;
 - $(f_{lo2} \pm f_{if2}) \pm f_{lo1}$;

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.

If the measurements are within 10 dB of the limit, the integers n and p need not exceed 10, otherwise the upper frequency of the test shall be 2 GHz.

Care 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.

Where measurements are made close to the wanted signal, the levels and tests provided for these conditions in the present document shall take precedence. No testing is necessary closer than 20 kHz to the wanted signal.

The receiver shall be set up in accordance with clause 9.3.2. 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.

Class of emission J3E and Class of emission F1B (analogue output)

The wanted signal represented by signal generator A shall be at the nominal frequency and shall have test modulation according to clause 6.2.2, the level shall be at the sensitivity level required in table 6.

Signal generator B shall have a level of at least 80 dB above the level of signal generator A, and the frequencies shall be according to the above mentioned.

For each spurious response found the carrier frequency of the input signal shall be adjusted to give maximum output power. The input level shall then be adjusted until a SINAD ratio of 14 dB at the output of the receiver is achieved.

The ratio between the input level of each spurious signal and the input of the wanted signal giving the same SINAD ratio shall then be evaluated.

Class of emission F1B (digital output)

The level of signal generator A shall be 3 dB above the sensitivity level required in table 6.

Signal generator B shall be at the level 70 dB above the level of signal generator A, and the frequencies shall be according to the above mentioned.

9.6.3 Limits

Class of emission J3E and Class of emission F1B (analogue output)

The spurious response rejection ratio shall not be less than 60 dB.

Class of emission F1B (digital output)

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

9.7 Receiver frequency error

9.7.1 Definition

The frequency error of the receiver is:

- a) for SSB telephony:
 - the absolute frequency error of the 1 000 Hz output frequency when the receiver is tuned to the carrier frequency using the input signal defined in clause 6.2.2.1;
- b) for DSC with an analogue interface:
 - the absolute frequency error of the 1 700 Hz output frequency when the receiver is tuned to the assigned frequency using input signal defined in clause 6.2.2.2.

9.7.2 Method of measurement

- a) SSB telephony:
 - a standard input signal for J3E at a level of +60 dB μ V shall be applied to the receiver on the nominal frequency to which it is tuned. The frequency of the output at the 600 Ω terminals shall be measured and its difference from 1 000 Hz be recorded;
- b) DSC with analogue input:
 - a standard input signal for F1B shall be applied to the receiver on the assigned frequency to which it is tuned at level of +60 dB μ V. The frequency of the output on the DSC 600 Ω terminals shall be measured and its difference from 1 700 Hz be recorded.

Measurement shall be made under normal test conditions (see clause 5.3) and under extreme test conditions (see clauses 5.4.1 and 5.4.2 applied simultaneously).

9.7.3 Limit

The receiver frequency error shall be less than ± 10 Hz, after the warming up period specified in clause 4.2.4.

9.8 Unwanted frequency modulation

9.8.1 Definition

Unwanted frequency modulation is the deviation of output frequency which may occur due to a number of causes but especially when the complete equipment is vibrated over a specified range of frequencies and amplitudes.

9.8.2 Method of measurement

The receiver, complete with chassis covers and shock absorbers (if supplied), shall be clamped in its normal operating position to a vibrating table.

The receiver shall then be switched on, adjusted for the reception of class of emission J3E and after the warming-up period permitted under clause 4.2.4 a radio frequency test signal as detailed in clause 6.2.2.2 shall be applied to its input at a level of +60 dB μ V.

The receiver shall be adjusted to deliver standard output power at 1 kHz. The table shall be vibrated as detailed in clause 7.5.2. Any frequency deviation of the output signal occurring during this test, shall be measured using a suitable, calibrated, FM demodulator. The deviation meter bandwidth shall be ± 125 Hz.

If the receiver does not have telephony facilities then the same test is performed using the reception of class of emission F1B with the appropriate test signal at the same levels but with an output frequency of 1 700 Hz.

9.8.3 Limit

The frequency peak deviation shall not exceed ± 5 Hz.

9.9 Pass band

9.9.1 Definition

The pass band measured at the output of the receiver is the frequency band in which the attenuation relative to peak response does not exceed 6 dB.

9.9.2 Method of measurement

With the AGC operative, two unmodulated radio frequency test signals shall be applied to the input of the receiver in accordance with clause 6.2.1.

The frequency of one of these test signals shall be at a frequency 1 500 Hz above the carrier frequency to which the receiver is tuned, and its level shall be +60 dB μ V. This stabilizes the gain of the receiver. The other test signal shall be at a level +50 dB μ V and shall be varied in frequency from the nominal carrier frequency to 10 kHz above the carrier frequency, and its resultant audio output voltage and frequency shall be measured at a sufficient number of points, using a spectrum analyser or selective voltmeter, to enable the audio frequency pass band to be determined.

When measuring in the vicinity of 1 500 Hz, the frequency of the gain-stabilizing input signal shall be displaced to a frequency just outside the pass-band of the measuring instrument.

9.9.3 Limits

The audio frequency pass-band shall exceed 350 Hz to 2 700 Hz.

9.10 Reciprocal mixing

9.10.1 Definition

Reciprocal mixing is the transfer of the noise sidebands of the receivers' local oscillator(s) to a wanted signal due to the presence of a large wanted or unwanted signal.

9.10.2 Method of measurement

The measurement shall be carried out with the receiver in the mode of operation J3E, with the AGC operative, the RF/IF gain control (if fitted) at its maximum and any input attenuator at its minimum attenuation. The measurements shall be made by the simultaneous application of two test signals to the input of the receiver. One of the test signals is the wanted signal to which the receiver is tuned and the other the unwanted signal.

The wanted test signal shall be the normal test signal specified in clause 6.2.2 with a level of +60 dB μ V. The receiver shall be adjusted so that the wanted signal gives standard output power.

The unwanted signal shall have a frequency separation of ± 20 kHz, or more, relative to that of the receiver frequency and shall be unmodulated.

The input level of the unwanted signal is adjusted until it causes a reduction in the SNR to 30 dB. The input level of the unwanted signal is recorded and shall be taken as the reciprocal mixing level.

Care should be taken in the measurement to avoid the effects of distortion.

Care should be taken to ensure that the noise sideband of the generators representing the wanted, and especially the unwanted signals, does not influence the measurements.

9.10.3 Limit

The reciprocal mixing level shall be not less than +100 dB μ V.

9.11 Harmonic content in output

9.11.1 Definition

The harmonic content in the output of a telephony receiver is the total RMS voltage of all the individual harmonics of modulation frequencies, appearing at the receiver outputs as a result of non-linearity in the receiver. For purposes of test it is expressed as a percentage of the total RMS output voltage, when a single sinusoidal modulation is applied.

9.11.2 Method of measurement

This test shall be performed with rated output power and with standard output power. The test signals as defined in clause 6.2.2 shall be applied to the receiver input applicable for all modes of analogue modulation.

The level of the input signal shall be varied between +30 dB μ V and +80 dB μ V, while maintaining the output level at the standard output power and then at the rated output power. The harmonic content shall then be measured.

9.11.3 Limits

The harmonic content shall not exceed 10 % at rated output power and 5 % at standard output power.

9.12 Audio frequency intermodulation

9.12.1 Definition

Audio frequency intermodulation is a process by which signals are produced from two or more wanted signals simultaneously present in the demodulator and/or audio amplifier of a telephony receiver. It is expressed in terms of the ratio of the level of each intermodulation component relative to the level of one or two test signals of equal amplitude.

9.12.2 Method of measurement

With the AGC operative, the manual RF/IF gain control (if provided) at its maximum, and any input attenuator adjusted to its minimum attenuation, an unmodulated signal, 1 100 Hz above the frequency to which the receiver is tuned, at a level of +60 dB μ V shall be applied to the input of the receiver. In addition a second unmodulated signal, 1 700 Hz above the frequency to which the receiver is tuned shall be applied and its level shall be adjusted until the 1 100 Hz and the 1 700 Hz signals in the output of the receiver are of equal amplitude.

By means of the audio frequency gain control the total output power of the receiver shall be adjusted to standard output power.

The audio frequency intermodulation components shall then be measured.

9.12.3 Limit

The value of any of the intermodulation components shall not exceed -25 dB relative to the output level of any one of the two wanted signals.

9.13 Internally generated spurious signals

9.13.1 Definition

Internally generated spurious signals are those signals that may appear in the output of a receiver due to mixing processes in the receiver system without any antenna input signal.

9.13.2 Method of measurement

The receiver shall have no input signal and be terminated at its antenna input with a load impedance equal to those specified in clause 6.1.2. The receiver shall be set to J3E mode and a search made throughout the bands for whistles in the output. For conformance testing manufacturers may need to provide a means for quickly searching the bands in steps of no more than 1 kHz.

9.13.3 Limits

There shall be no internally generated spurious signals on any designated distress frequency and its associated guard bands. On all other channels where spurious occur, the level shall be less than 10 dB above the inherent noise level.

9.14 AGC efficiency

9.14.1 Definition

The AGC efficiency of the receiver is the ability to keep the change of audio output level within limits when the RF input voltage is varied over a specified range.

9.14.2 Method of measurement

9.14.2.1 General

Under the test conditions specified in clause 9.14.2.2 the receiver shall be adjusted to give an output level 10 dB below the standard output power. The input level shall then be increased by 70 dB. The resulting increase in output power shall be compared to the limit in clause 9.14.3.

9.14.2.2 Settings

To check the performance of the AGC, tests shall be carried out with the receiver adjusted for each maritime mobile band. The input signal shall be the appropriate normal test signal specified in clause 6.2.2. The characteristics shall be checked at all audio outputs.

9.14.2.3 Increase in Signal-to-Noise Ratio (SNR)

For each test the input signal shall have a level equal to the maximum usable sensitivity measured according to clause 9.2. The input level shall then be increased by 20 dB. The SNR shall then increase by at least 15 dB.

Care should be taken in the measurement to avoid the effects of distortion.

9.14.3 Limits

The resulting increase in output power shall not exceed 10 dB.

9.15 AGC time constants (attack and recovery time)

9.15.1 Definition

AGC attack time: the elapsed time from the instant at which the input-signal level is suddenly increased by a specified amount, until the instant at which the level of the output signal reaches and remains within ± 2 dB of the subsequent steady-state value.

AGC recovery time: the elapsed time from the instant when the input-signal level is suddenly decreased by a specified amount, until the instant at which the output signal reaches and remains within ± 2 dB of the subsequent steady-state value.

9.15.2 Method of measurement

A test signal (see clause 6.2.2) shall be applied to the input of the receiver set in the J3E mode via an attenuator capable of being switched in a single step of 30 dB without interrupting the test signal. The resulting audio output shall be displayed by means of an oscilloscope.

The input level shall be adjusted to produce an output SNR ratio of 20 dB, and the output level adjusted to 10 dB below the standard audio-frequency output power. The attenuator shall then be switched so that the input signal increases in level by 30 dB.

The attack time shall then be measured. The attenuator shall then be switched so that the input signal returns to its original level. The recovery time shall be measured.

Care should be taken in the measurement to avoid the effects of distortion.

9.15.3 Limits

AGC attack time shall be between 5 ms and 10 ms ($5 \text{ ms} \leq \text{AGC attack time} \leq 10 \text{ ms}$).

AGC recovery time shall be between 1 s and 4 s ($1 \text{ s} \leq \text{AGC recovery time} \leq 4 \text{ s}$).

9.16 Protection of input circuits

9.16.1 Definition

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

9.16.2 Method of measurement

An unmodulated radio frequency test signal, at a level of 30 V emf is applied, in the manner specified in clause 6.1.2 to the receiver input for a period of 15 min.

The test shall be performed on 2 182 kHz if the equipment is designed to operate in the 1 606,5 kHz to 4 000 kHz bands only, or on a frequency in the 8 MHz band if the equipment is designed to operate on all maritime bands in the 1 606,5 kHz to 27 500 kHz range.

9.16.3 Requirement

The receiver shall operate normally without further attention when the test signal is removed.

10 Testing for compliance with technical requirements

10.1 Environmental conditions for testing

These shall be as described clause 5.

10.2 Interpretation of the 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 value of the measurement uncertainty for the measurement of each parameter shall be included in the test report;
- the recorded value of the measurement uncertainty shall be, for each measurement, equal to or less than the figures in table 10.

For the test methods, according to the present document, the measurement uncertainty figures shall be calculated and shall correspond to an expansion factor (coverage factor) $k = 1,96$ or $k = 2$ (which provide confidence levels of respectively 95 % and 95,45 % in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian)). Principles for the calculation of measurement uncertainty are contained in ETSI TR 100 028 [i.2] and [i.3], in particular in annex D of the ETSI TR 100 028-2 [i.3].

Table 10 is based on such expansion factors.

Table 10: Absolute measurement uncertainties: maximum values

Parameter	Uncertainty
RF frequency	$\pm 1 \times 10^{-8}$
RF Power, PEP in 50 Ω	$\pm 1,5$ dB
RF Power, PEP in 10 Ω /250 pF	$\pm 2,5$ dB
Conducted spurious emissions of transmitter	± 4 dB
Radiated spurious emissions	± 6 dB
Audio output power	$\pm 0,5$ dB
Sensitivity of receiver	± 3 dB
Conducted emission of receiver	± 3 dB
Two signal measurement	± 4 dB
Three signal measurement	± 3 dB

Annex A (informative): Relationship between the present document and the essential requirements of Directive 2014/53/EU

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.12] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.1].

Once the present document is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of the present document given in tables A.1 and A.2 confers, within the limits of the scope of the present document, a presumption of conformity with the corresponding essential requirements of that Directive, and associated EFTA regulations.

Table A.1: Relationship between the present document and the essential requirements of Directive 2014/53/EU

Harmonised Standard ETSI EN 303 402				
Requirement			Requirement Conditionality	
No	Description	Reference: Clause No	U/C	Condition
1	Frequency error	8.1	U	
2	Output power and intermodulation products	8.2	U	
3	Power of out-of-band emissions of SSB telephony	8.3	U	
4	Power of conducted spurious emissions of SSB telephony	8.4	U	
5	Carrier suppression	8.5	U	
6	Transmitter radiated spurious emissions	8.14	U	
7	Receiver spurious emissions	9.1	U	
8	Maximum usable sensitivity	9.2	U	
9	Adjacent signal selectivity	9.3	U	
10	Blocking or desensitization	9.4	U	
11	Intermodulation response	9.5	U	
12	Spurious response rejection ratio	9.6	U	

Table A.2: Relationship between the present document and Article(s) 3.3(g) of Directive 2014/53/EU

Harmonised Standard ETSI EN 303 402				
Requirement			Requirement Conditionality	
No	Description	Reference: Clause No	U/C	Condition
1	General, operational and technical requirements	4.2	U	
2	Dry heat	7.4.2	U	
3	Damp heat	7.4.3	U	
4	Low temperature cycle	7.4.4	U	
5	Vibration	7.5	U	
6	Corrosion	7.6	C	See clause 7.6.1 applicability
7	Rain	7.7	C	Equipment mounted above deck
8	Unwanted frequency modulation	8.6	U	
9	Sensitivity of the microphone and the 600 Ω line inputs for SSB telephony	8.7	U	
10	Automatic level control and/or limiter for SSB telephony	8.8	U	
11	Audio frequency response of SSB telephony	8.9	U	
12	Residual hum and noise power for telephony	8.10	U	
13	Residual frequency modulation on DSC	8.11	U	
14	Continuous operation of telephony	8.12	U	
15	Protection of transmitter	8.13	U	

Harmonised Standard ETSI EN 303 402				
Requirement			Requirement Conditionality	
No	Description	Reference: Clause No	U/C	Condition
16	Receiver frequency error	9.7	U	
17	Unwanted frequency modulation	9.8	U	
18	Pass band	9.9	U	
19	Reciprocal mixing	9.10	U	
20	Harmonic content in output	9.11	U	
21	Audio frequency intermod	9.12	U	
22	Internally generated spurious signals	9.13	U	
23	AGC efficiency	9.14	U	
24	AGC time constants	9.15	U	
25	Protection of input circuits	9.16	U	

Key to columns:**Requirement:**

- No** A unique identifier for one row of the table which may be used to identify a requirement.
- Description** A textual reference to the requirement.
- Clause Number** Identification of clause(s) defining the requirement in the present document unless another document is referenced explicitly.

Requirement Conditionality:

- U/C** Indicates whether the requirement is unconditionally applicable (U) or is conditional upon the manufacturer's claimed functionality of the equipment (C).
- Condition** Explains the conditions when the requirement is or is not applicable for a requirement which is classified "conditional".

Presumption of conformity stays valid only as long as a reference to the present document is maintained in the list published in the Official Journal of the European Union. Users of the present document should consult frequently the latest list published in the Official Journal of the European Union.

Other Union legislation may be applicable to the product(s) falling within the scope of the present document.

Annex B (informative): Bibliography

- ETSI EN 301 843 (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for marine radio equipment and services".
- ETSI EN 300 373-1: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Maritime mobile transmitters and receivers for use in the MF and HF bands. Part 1: Technical characteristics and methods of measurement".

Annex C (informative): Change history

Version	Information about changes
2.1.1	First version aligned with the Radio Equipment Directive for articles 3.2 and 3.3(g)
2.1.2	Editorial corrections implemented (clarification in clauses 8.2.3.1, 8.2.3.2 and 8.12.3)

History

Document history		
V2.1.1	May 2017	Publication
V2.1.2	September 2017	Publication