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**Maritime mobile broadband communication links;
Radio transmitters and receivers employing
integrated beamforming phased array antennas
operating in the 5 GHz to 8 GHz frequency range**

Reference
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Keywords
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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

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 utilizing integrated beamforming phased array antennas operating on frequencies in the 5 GHz to 8 GHz frequency range, except for 5 862 MHz and 5 890 MHz, for broadband communication links between ships and between ships and land based stations.

The present document intends to provide parameters that may be useful when considering license or other permissions for use.

NOTE: Operation on the frequencies 5 862 MHz and 5 890 MHz is covered by ETSI EN 303 276 [i.1].

2 References

2.1 Normative 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.

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

[1] Recommendation ITU-T O.150 (05-1996) plus corrigendum 1 (05-2002): "General requirements for instrumentation for performance measurements on digital transmission equipment".

[2] 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".

[3] Recommendation ITU-T 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".

[4] ISO 25862:2019: "Ships and marine technology -- Marine magnetic compasses, binnacles and azimuth reading devices".

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.

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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] ETSI EN 303 276: "Maritime Broadband Radiolink operating within the bands 5 852 MHz to 5 872 MHz and/or 5 880 MHz to 5 900 MHz for ships and off-shore installations engaged in coordinated activities; Harmonised Standard for access to radio spectrum".

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

tuning range: maximum frequency band within which an equipment can operate

3.2 Symbols

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

C_F	Minimum number of frames
dBi	Level (dB) relative to isotropic antenna
dBm	Level (dB) relative to 1 mW
f	frequency
N	Number of transmitted bits
ppm	parts per million (10^{-6})
s	second
V	Volt
Q	Q factor is a resonance parameter

3.3 Abbreviations

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

ac	alternating current
ATPC	Adaptive Transmitter Power Control
BER	Bit Error Rate
CRC	Cyclic Redundancy Check
dc	direct current
EIRP	Equivalent Isotropic Radiated Power
EN	European Norm
EUT	Equipment Under Test
FER	Frame Error Rate
ISO	International Organization for Standardization
ITU-T	International Telecommunication Union - Telecommunication standardization sector
RBW	Reference BandWidth
RF	Radio Frequency
TS	Technical Specification

4 General and operational 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 in accordance with its intended use and 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 at all times when operating within the boundary limits of the operational environmental profile defined by its intended use.

4.2 Main characteristics of the beamforming system

The beamforming system allows for a broadband connection to be established using automatic transmit power control in both directions in order to maintain the required signal level at the receiver input.

Both stations employ phased array antennas which produce dynamically shaped and steerable beams such that the stations mutually track each other.

The beamforming process is controlled via software algorithms which also enable the detection and suppression of unwanted interfering signals, by means of signal processing techniques applied at the receiver including the placement of directional nulls in the antenna patterns. Such techniques also enable nulls to be dynamically placed in the transmitted radiation pattern, thereby suppressing the power emitted in given directions.

4.3 Construction

The mechanical and electrical construction and finish of the equipment shall conform in all respects to good engineering practice, and the equipment shall be suitable for use on board ships or for installation at land based stations.

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.

For the purpose of conformance testing, relevant technical documentation shall be supplied with the equipment.

The equipment shall be capable of operating on single frequency channels.

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

4.4 Controls and indicators

The equipment shall have a frequency selector and shall indicate the operating frequency at which the installation is set and this shall be legible irrespective of the external lighting conditions.

Where an input panel on the equipment for entering the digits 0 - 9 is provided, this shall conform to Recommendation ITU-T E.161 [3].

The equipment shall have the following additional controls and indicators:

- a means for reducing the brightness of the equipment illumination to almost zero;
- an on/off switch for the entire installation with a visual indication that the installation is in operation;
- a visual indication that the equipment is transmitting.

The equipment shall also meet the following requirements:

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

4.5 Safety precautions

Measures shall be taken to protect the equipment against the effects of overcurrent or overvoltage.

Measures shall be taken to prevent damage to the equipment if the electrical power source produces transient voltage variations and to prevent any damage that might arise from an accidental reversal of polarity of the electrical power source.

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

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

The information in any volatile memory device shall be protected from interruptions in the power supply of up to at least 60 s duration.

4.6 Labelling

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

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

For installation on board ships, the compass safe distance as defined in ISO 25862 [4] (Method B) shall be stated on the equipment or in the technical manual.

4.7 Frequencies

The equipment shall be capable of operating on frequencies between 5 GHz and 8 GHz. The tuning range of the equipment shall be declared by the manufacturer.

4.8 Polarization of the antenna

The equipment shall operate with vertical or lefthand circular polarization.

4.9 Antenna gain

The antenna gain of the equipment shall be declared by the manufacturer. The antenna gain shall be at least 15 dBi.

4.10 Transceiver data interface

Equipment shall provide a digital connection such as Ethernet or other suitable interfaces for access to the equipment.

5 General conditions of measurements

5.1 Test site and general arrangements for measurements

Measurements of the equipment shall be done by radiated measurements in an anechoic chamber. Descriptions of the anechoic chamber and radiated measurement arrangements are included in ETSI TS 103 052 [2].

The antennas of the transmitter and the receiver shall be at the same height.

The measurement antenna shall be placed as close as possible to the EUT receiver antenna and shall be adjusted to the same height as the antenna for the transmitter and the receiver.

The measurement antenna shall be adjusted in the direction of the transmitter antenna.

The measurement antenna and spectrum analyser shall be calibrated to read absolute values.

5.2 General

Tests shall be carried out on the highest and lowest frequency available in the equipment.

5.3 Tests of equipment with a notch filter

A notch filter may be required to obtain the required dynamic range for measurement of the transmitter.

If a notch filter is used, it shall be centred on the transmitter carrier frequency and attenuating the signal by at least 30 dB. The measured results shall be corrected for the loss in the notch filter.

5.4 Coupling arrangement facilities for access

Equipment to be connected to the Equipment Under Test (EUT) shall be connected by a method which does not affect the radiated field.

5.5 Modes of operation of the transmitter

For the purpose of the measurements according to the present document, the transmitter shall be able to generate the necessary test signals described in clause 6.2.

5.6 Sources of test signals

Sources of test signals for the measurements of the receiver may be a transmitter with variable output power.

5.7 Bit error measurements

All BER measurements shall be conducted by field radiation with measurement of the BER in an indirect way. The indirect way is based on generating and receiving frames of limited length where any bit errors in the frame can be detected by means of a Cyclic Redundancy Check (CRC). The fraction of erroneous frames out of the total number of frames, which is called the Frame Error Rate (FER), allows to estimate the BER assuming that bit errors are equally distributed.

Assuming equally distributed and statistically independent occurrence of erroneous bits the following relations between FER, BER and total number N of transmitted bits within a single frame apply:

$$FER = 1-(1-BER)^{N},$$

$$BER = 1-10^{\log(1-FER)/N} = 1-(1-FER)^{1/N}$$

The minimum number C_F of frames together with the frame size shall be reported.

EXAMPLE 1: With BER = 10^{-6} and frame length N = 1 000, the equivalent FER is approximately 0,001.

The reasonable number C_F of frames to be transmitted is 10 000, i.e. 10 frames may be lost on average.

EXAMPLE 2: For a large value of FER, e.g. 0,9999 which may result in a BER = $2{,}0\cdot10^{-2}$ as used for test, a reasonable number C_F of frames to be transmitted is 100 000, i.e. 10 frames may be error-free on average. The very large number of frames to be transmitted is to be able to estimate the BER as a small variation in erroneous frames may change significantly the corresponding estimated BER.

6 Test conditions

6.1 General

Tests shall be made under normal test conditions and also, where stated, under extreme test conditions.

NOTE: Normal and extreme test conditions are defined in clause 6.3 and clause 6.4.

6.2 Test signals

Test signal 1 shall be an unmodulated carrier.

Test signal 2 shall be a message consisting of a pseudo-random bit sequence of at least 8 192 payload bits according to clause 5 of Recommendation ITU-T O.150 [1]. The bit modulation rate over the air shall be 10 Mb/s.

6.3 Normal test conditions

6.3.1 Normal temperature and humidity

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

- temperature: +15 °C to +35 °C;
- relative humidity: not exceeding 75 %.

6.3.2 Normal power source

6.3.2.1 Mains voltage and frequency

The normal test voltage shall be the nominal ac mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage or any of the declared voltages for which the equipment is indicated as having been designed. The frequency of the test voltage shall be 50 Hz ± 1 Hz.

6.3.2.2 Battery power source

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

6.3.2.3 Other power sources

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

6.4 Extreme test conditions

6.4.1 General requirements

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

6.4.2 Extreme temperatures

For tests at extreme temperatures, measurements shall be made in accordance with clause 6.4.4, at a lower temperature of -15 °C and an upper temperature of +55 °C.

6.4.3 Extreme values of test power source

6.4.3.1 Mains voltage and frequency

The extreme test voltages shall be the nominal ac mains voltage ±10 %. The frequency of the test voltage shall be 50 Hz ±1 Hz.

6.4.3.2 Battery power source

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

6.4.3.3 Other power sources

For operation from other power sources the extreme test voltages shall be declared by the equipment manufacturer.

6.4.4 Procedure for tests at extreme temperatures

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

Before conducting tests at the upper temperature, the equipment consisting of a transmitter and associated receiver, shall be placed in the test chamber and left until thermal equilibrium is reached. The equipment shall then be switched on for half an hour in normal transmit mode in the high power transmit condition at the normal voltage and the equipment shall meet the requirement of the present document.

For tests at the lower temperature, the equipment shall be left in the test chamber until thermal equilibrium is reached and shall then be switched on, after which the equipment shall meet the requirements of the present document.

For tests at extreme temperatures, the manufacturer may be required to provide an RF transparent test cabinet.

7 Environmental tests

7.1 General requirements

The equipment shall be capable of continuous operation under the conditions of vibration, humidity and change of temperatures likely to be experienced at sites where it is installed.

7.2 Performance check

Performance check consists of transmitting and receiving test signal 2 and measuring the BER. The signal level at the receiving antenna shall be higher than -80 dBm and the receiver BER shall be better than 10^{-5}.

7.3 Vibration tests

7.3.1 Purpose

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

7.3.2 Method of measurement

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

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

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

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

A resonance search shall be carried out throughout the test. If any resonance of the EUT has $Q \geq 5$ measured relative to the base of the vibration table, the EUT shall be subjected to a further vibration endurance test at each resonant frequency at the vibration level specified in the test with a duration of two hours. If any resonance with $Q < 5$ occurs the further endurance test shall be carried out at one single observed frequency. If no resonance occurred, the further endurance test shall be carried out at a frequency of 30 Hz.

Performance check(s) shall be carried out at the end of each two hours endurance test period.

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

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

7.3.3 Requirement

The equipment shall meet the requirements of the performance check defined in clause 7.2.

There shall be no harmful deterioration of the equipment visible.

7.4 Damp heat

7.4.1 Purpose

This test determines the ability of equipment to withstand conditions of high humidity.

7.4.2 Method of measurement

The EUT shall be placed in a chamber at normal room temperature and relative humidity. The temperature shall then be raised to +40 °C ±2 °C, and the relative humidity raised to 93 % ±3 % over a period of three hours ±0,5 hour. These conditions shall be maintained for a period of 10 to 16 hours. The temperature and relative humidity of the chamber shall be maintained as specified during the whole period. Any climatic control devices provided in the EUT may be switched on at the conclusion of this period. The EUT shall be switched on 30 minutes later, or after such period as agreed by the manufacturer, and shall be kept operational for at least two hours. At the end of the test period and with the EUT still in the chamber, the chamber shall be brought to room temperature in not less than one hour and the EUT shall be returned to normal environmental conditions or to those required at the start of the next test. The maximum rate of raising or reducing the temperature of the chamber in which the equipment is being tested shall be 1 °C per minute. Immediately after the test period, the EUT shall be subject to the performance check defined in clause 7.2.

7.4.3 Requirement

The equipment shall meet the requirements of the performance check defined in clause 7.2.

8 Transmitter

8.1 Frequency error

8.1.1 Definition

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

8.1.2 Method of measurement

The measurement set up shall be as in Figure 1.

The EUT transmitter shall be configured to operate on the highest frequency available in the equipment, at normal RF output power level using test signal 1.

The measurement antenna shall be connected to a frequency counter.

The transmitter frequency shall be measured.

Measurements shall be made under normal test conditions (clause 6.3) and under extreme test conditions (clause 6.4).

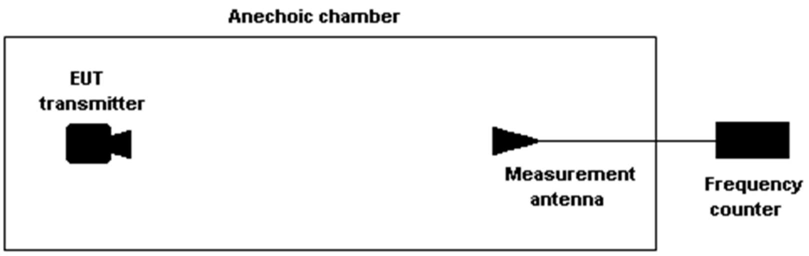

Figure 1: Measurement set up for transmitter operating frequency

8.1.3 Limit

The measured frequency shall be within the range ±2 ppm of the nominal value.

8.2 Equivalent Isotropic Radiated Power

8.2.1 Definition

The Equivalent Isotropic Radiated Power (EIRP) of the transmitter is the maximum radiated power of the equipment with its associated antenna.

8.2.2 Method of measurement

The measurement set up shall be as in Figure 2.

The EUT transmitter antenna beam shall be configured to maximum antenna gain and pointed towards the measurement antenna. The transmitter shall be configured to operate at maximum RF output power level using test signal 1.

The measurement antenna shall be connected to a spectrum analyser.

Max Hold (peak detector) shall be selected and the centre frequency adjusted to that of the EUT.

The peak value of the power envelope shall be measured.

The substitution method described in clause 4 of ETSI TS 103 052 [2] shall be used.

Measurements shall be made under normal test conditions (clause 6.3) and under extreme test conditions (clause 6.4).

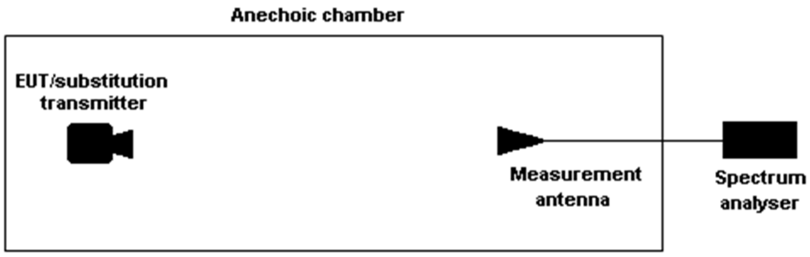

Figure 2: Measurement set up for transmitter EIRP

8.2.3 Limit

The EIRP shall not exceed 55 dBm.

8.3 Half power antenna beam width

8.3.1 Definition

The half power antenna beam width is the angle of radiation within which the radiated power is between 0 dB and -3 dB of the bore sight radiation.

8.3.2 Method of measurement

The measurement set up shall be as in Figure 3.

The transmitter shall be configured to operate at maximum RF output power level using test signal 1.

The measurement antenna shall be connected to a spectrum analyser.

The antenna beam shall be configured to maximum gain and pointed towards the measurement antenna.

The received value shall be noted.

The antenna shall then be rotated clockwise and counter clockwise 20º of the bore sight and the received values shall be noted.

The measurement shall be performed in the horizontal plane only.

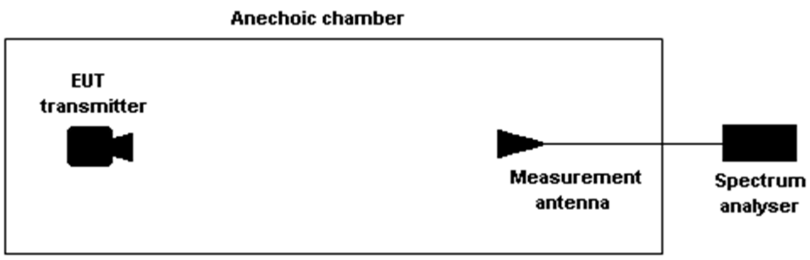

Figure 3: Measurement set up for antenna beam width

8.3.3 Limit

The -3 dB points of the antenna pattern shall be within ±15º of the bore sight.

8.4 Adaptive Transmitter Power Control

8.4.1 Definition

Adaptive power control is an automatic mechanism to regulate the transmitter output power.

8.4.2 Method of measurement

The measurement set up shall be as in Figure 4.

For the measurement, two equipment (transceivers A and B) shall be used to establish a normal communication link using test signal 2.

The equipment under test (transmitter A) shall be operated with the Adaptive Transmitter Power Control (ATPC) inactive at a power level that produces a signal level of at least 50 dB above the sensitivity level (see clause 9.1) at receiver B.

The measurement antenna shall be connected to a spectrum analyser.

The output power of the equipment under test (transmitter A) shall be measured.

The ATPC in the equipment under test (transmitter A) shall then be activated and the change of the output power shall be measured.

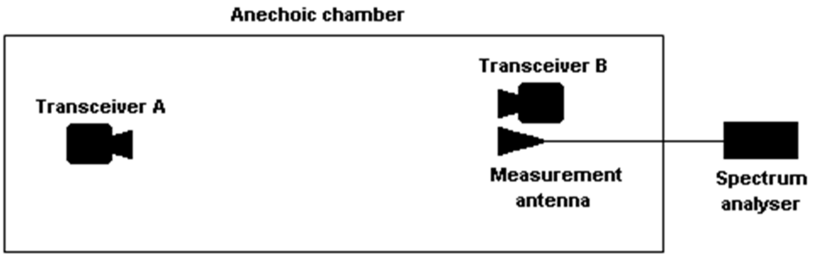

Figure 4: Measurement set up for ATPC

8.4.3 Limit

The output power of the EUT shall be reduced by the ATPC by at least 25 dB.

8.5 Spectrum mask

8.5.1 Definition

A spectrum mask is a set of limit lines applied to a plot of a transmitter spectrum. The transmitter spectrum mask defines emission limits in the out-of-band domain.

8.5.2 Method of measurement

The measurement set up shall be as in Figure 5.

The EUT transmitter shall be configured to operate at a maximum EIRP using test signal 2.

The EUT antenna beam shall be configured to maximum gain and pointed towards the measurement antenna.

The measurement antenna shall be connected to a spectrum analyser.

Max Hold (peak detector) shall be selected and the centre frequency adjusted to that of the EUT.

The measurement shall be performed with a measuring bandwidth of 1 MHz.

The value of the power shall be measured over the frequency range between -50 MHz and +50 MHz relative to the centre frequency.

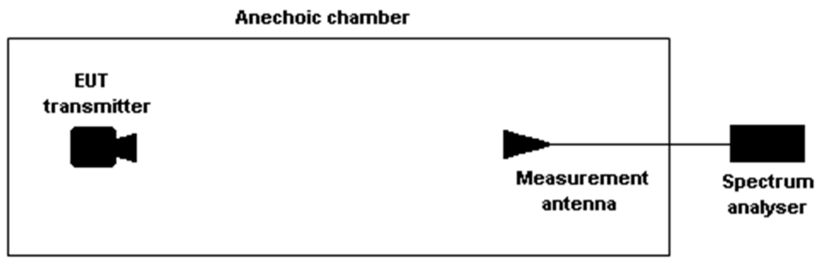

Figure 5: Measurement set up for transmitter spectrum mask

8.5.3 Limit

The emissions shall not exceed the transmitter spectrum mask in Figure 6 or an absolute level of -30 dBm/MHz, whichever is greater.

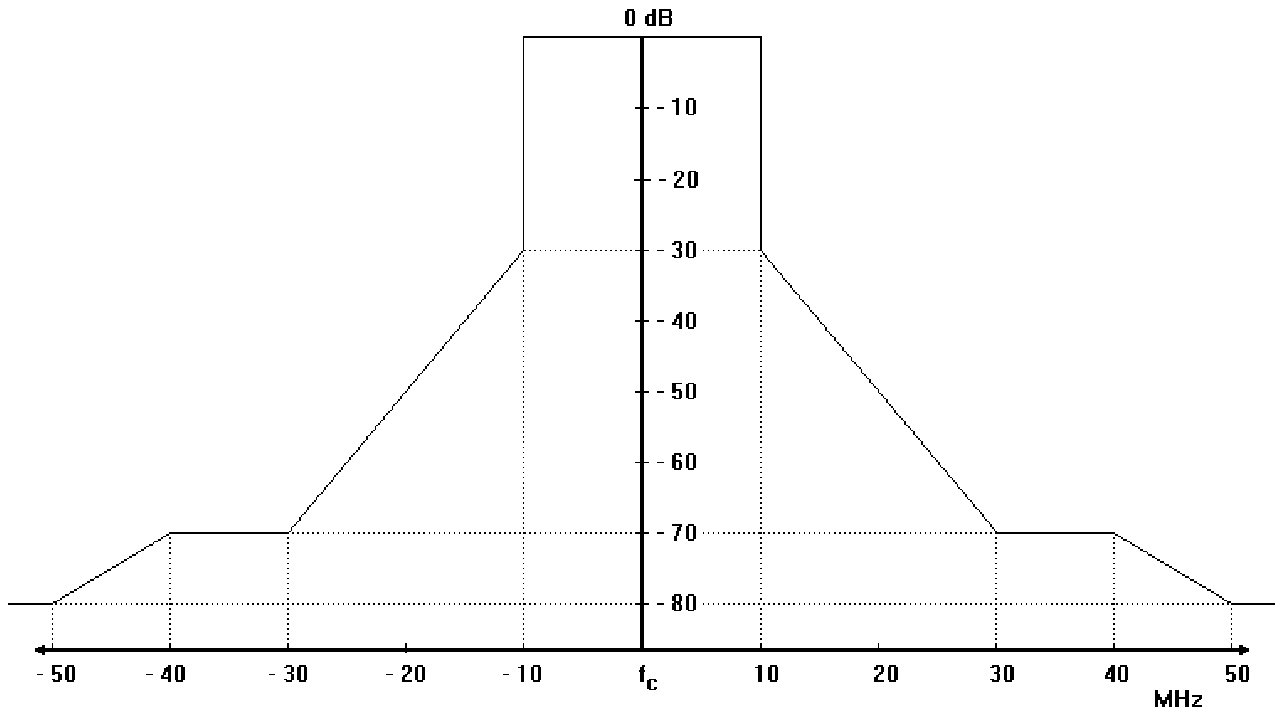

Figure 6: Transmitter power spectrum mask

8.6 Spurious emissions

8.6.1 Definition

Spurious emission is emission on a frequency or frequencies outside the out-of-band domain and the level of which may be reduced without affecting the corresponding transmission of information.

8.6.2 Method of measurement

The measurement set up shall be as in Figure 7.

The EUT transmitter shall be configured to operate at maximum EIRP level using test signal 1.

The EUT transmitter antenna beam shall be configured to maximum gain and pointed towards the measurement antenna.

The measurement antenna shall be connected to a spectrum analyser. A notch filter may be required to obtain the required dynamic range for measurement, see clause 5.3.

Max Hold (peak detector) shall be selected.

The measurement shall be made over the frequency range from 30 MHz to 26 GHz excluding the channel on which the transmitter is operating and the out of band domain (f_c ± 50 MHz). The reference bandwidths shall be in accordance with Table 1.

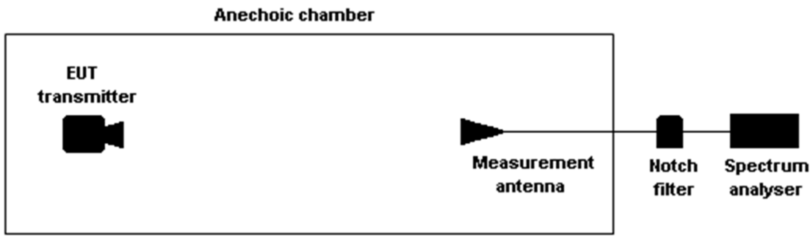

Figure 7: Measurement set up for transmitter spurious emissions

8.6.3 Limit

Any radiated spurious emission level shall not exceed the limits in Table 1.

Table 1: Transmitter spurious emissions limits and measurement bandwidth

Frequency range	Emission Limits	RBW
30 MHz ≤ f ≤ 1 GHz	-40 dBm	100 kHz
1 GHz < f ≤ 26 GHz	-30 dBm	1 MHz

9 Receiver

9.1 Maximum usable sensitivity

9.1.1 Definition

The maximum usable sensitivity of the receiver (data or messages) is the minimum level of signal at the receiver input at the nominal frequency of the receiver, which will, without interference, produce after demodulation stable and correct readings of data below a specified error ratio or a specified successful message ratio.

9.1.2 Method of measurement

The measurement set up shall be as in Figure 8.

A test signal transmitter shall be configured to transmit test signal 2.

The measurement antenna shall be connected to a spectrum analyser.

The centre frequency shall be adjusted to that of the EUT receiver. The measuring bandwidth shall be 20 MHz.

The transmitter signal level shall be reduced in 1 dB steps until the received BER exceeds 10^{-5}.

The sensitivity of the receiver is calculated from the reading on the spectrum analyser, taking into account the EUT receiver antenna gain.

Measurements shall be made under normal test conditions (clause 6.3) and under extreme test conditions (clause 6.4).

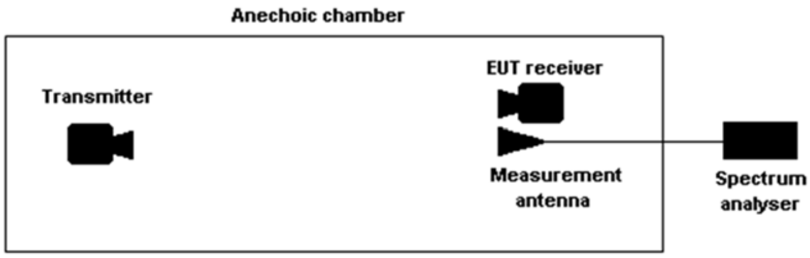

Figure 8: Measurement set up for receiver sensitivity

9.1.3 Limit

The maximum usable sensitivity of the receiver shall be better than -83 dBm.

9.2 Co-channel rejection

9.2.1 Definition

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

9.2.2 Method of measurement

The measurement set up shall be as in Figure 9.

For the measurement, two signal generators shall be used (generator A and B). Both generators shall operate on the nominal frequency of the EUT receiver and shall be adjusted to produce test signal 2.

The two signal generators shall be fed to calibrated antennas of equal gain, each within the 3 dB beam width of the antenna of the receiver under test.

The measurement antenna shall be connected to a spectrum analyser.

Initially, generator B (unwanted signal) shall be switched off.

The wanted signal shall be provided by signal generator A and shall produce signal level +3 dB above the sensitivity level of the EUT receiver (see clause 9.1) and radio link shall be established with the EUT.

Signal generator B shall then be switched on and the level of the unwanted signal adjusted until the received BER exceeds 10^{-5}.

The signal levels of generators A and B shall be measured.

The co-channel rejection ratio shall be expressed as the average ratio, in dB, between the level of the unwanted signal (generator B) and the level of the wanted signal (generator A).

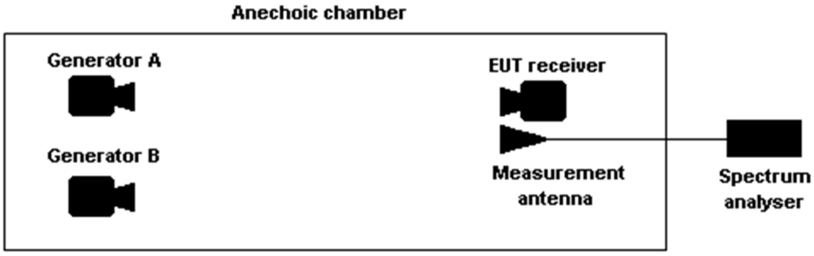

Figure 9: Measurement set up for receiver co-channel rejection

9.2.3 Limit

The co-channel rejection at the nominal frequency of the receiver shall be better than -13 dB.

9.3 Adjacent channel selectivity

9.3.1 Definition

The adjacent channel selectivity is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted signal which differs in frequency from the wanted signal by an amount equal to the adjacent channel separation for which the equipment is designed.

9.3.2 Method of measurement

The measurement set up shall be as in Figure 10.

For the measurement, two signal generators shall be used (generator A and B). Both generators shall be adjusted to produce test signal 2. The signal generators shall operate on frequencies separated by 40 MHz.

The two signal generators shall be fed to antennas of equal gain, both within the 3 dB beam width of the antenna of the EUT receiver.

The measurement antenna shall be connected to a spectrum analyser.

Signal generator A (wanted signal) shall operate on the nominal frequency of the receiver under test.

Initially, signal generator B (unwanted signal) shall be switched off.

The wanted signal shall be provided by signal generator A with a level +3 dB above the sensitivity level of the EUT receiver (see clause 9.1) and radio link shall be established with the EUT.

Signal generator B shall then be switched on and the level of the unwanted signal adjusted until the received BER exceeds 10^{-5}.

The signal levels of generators A and B shall be measured.

The adjacent channel selectivity shall be expressed as the ratio, in dB, between the level of the unwanted signal (signal generator B) and the level of the wanted signal (signal generator A).

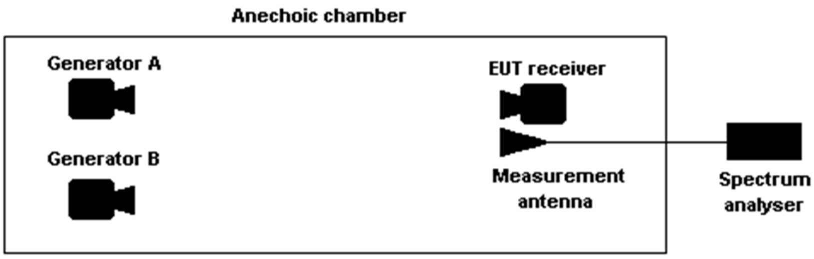

Figure 10: Measurement set up for receiver adjacent channel

9.3.3 Limit

The adjacent channel selectivity shall be greater than 40 dB.

9.4 Blocking

9.4.1 Definition

Blocking is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted input signal at any frequencies other than those of the spurious responses or the adjacent channels.

9.4.2 Method of measurement

The measurement set up shall be as in Figure 11.

For the measurement, two signal generators shall be used.

The test signal generator A (wanted signal) shall be configured to operate with test signal 2 at the nominal frequency of the EUT receiver (transceiver B). The unwanted signal generator shall be unmodulated at frequency ±500 MHz and ±1 GHz from the nominal frequency of the EUT receiver.

The two signal generators shall be fed to antennas of equal gain, each within the 3 dB beam width of the antenna of the EUT receiver.

The measurement antenna shall be connected to a spectrum analyser.

Initially, the unwanted signal generator shall be switched off.

The wanted signal shall be provided by signal generator A with signal level +3 dB above the sensitivity level of the EUT receiver, (see clause 9.1) and radio link with EUT shall be established.

The unwanted signal provided by the signal generator shall then be switched on and the level of the unwanted signal adjusted until the received BER exceeds 10^{-5}.

The blocking level shall be expressed as the ratio, in dB, between the level of the unwanted signal (signal generator B) and the level of the wanted signal (signal generator A).

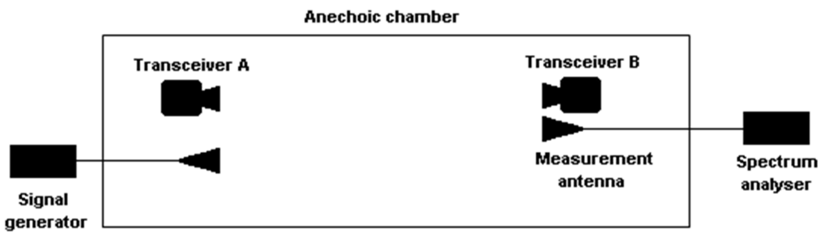

Figure 11: Measurement set up for receive blocking

9.4.3 Limit

The blocking level for any of the above specified frequencies shall be greater than 55 dB.

9.5 Spurious emissions

9.5.1 Definition

Receiver spurious emissions are emissions at any frequency.

9.5.2 Method of measurement

The measurement set up shall be as in Figure 12.

The measurement antenna shall be connected to a spectrum analyser and Max Hold (peak detector) shall be selected.

The value of the emissions shall be measured.

The measurement shall be made over the frequency range from 30 MHz to 26 GHz. The reference bandwidths shall be in accordance with Table 2.

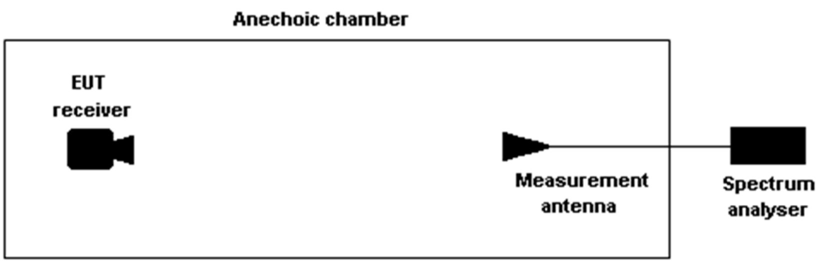

Figure 12: Measurement set up for receiver spurious emissions

9.5.3 Limits

The spurious emissions of the receiver shall not exceed the limits specified in Table 2.

Table 2: Receiver spurious emission limits and measurement bandwidth

Frequency range	Emission Limits	RBW
30 MHz ≤ f ≤ 1 GHz	-57 dBm	100 kHz
1 GHz < f ≤ 26 GHz	-47 dBm	1 MHz

History

Document history		
V1.1.1	January 2023	Publication