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**Electromagnetic compatibility
and Radio spectrum Matters (ERM);
Ground-based UHF radio transmitters, receivers
and transceivers for the UHF aeronautical mobile service
using amplitude modulation;
Part 1: Technical characteristics and methods of measurement**



Reference

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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM), and is now submitted for the Public Enquiry phase of the ETSI standards Two-step Approval Procedure.

Proposed national transposition dates	
Date of latest announcement of this EN (doa):	3 months after ETSI publication
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	6 months after doa
Date of withdrawal of any conflicting National Standard (dow):	6 months after doa

Introduction

The present document states the minimum performance requirements for ground based radio transmitters, transceivers and receivers for the aeronautical mobile service operating in the UHF band (225 MHz to 399,975 MHz), using Double Sideband Amplitude Modulation with 25 kHz channel spacing.

The present document may be used by accredited test laboratories for the assessment of the performance of the equipment. The performance of the equipment submitted for type testing should be representative for the performance of the corresponding production model.

The present document has been written on the assumption that:

- the type test measurements will be performed only once, in an accredited test laboratory and the measurements accepted by the various authorities in order to grant type approval;
- if equipment available on the market is required to be checked it will be tested in accordance with the methods of measurement specified in the present document.

1 Scope

The present document states the minimum performance requirements for radio transmitters receivers and transceivers at ground-based aeronautical stations operating in the UHF band (225 MHz to 399,975 MHz) allocated to the aeronautical mobile service.

The present document applies to DSB AM systems, with channel separations of 25 kHz intended for analogue speech.

The scope of the present document is limited to ground base stations.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific.

- For a specific reference, subsequent revisions do not apply.
- Non-specific reference may be made only to a complete document or a part thereof and only in the following cases:
 - if it is accepted that it will be possible to use all future changes of the referenced document for the purposes of the referring document;
 - for informative references.

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2.1 Normative references

- [1] ITU-T Recommendation O.41: "Psophometer for use on telephone-type circuits".

2.2 Informative references

- [2] ETSI EN 301 489 (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment".
- [3] ETSI TR 100 028 (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".
- [4] STANAG 4205 Technical Standards for Single Channel UHF Radio Equipment.

3 Definitions and abbreviations

3.1 Definitions

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

aeronautical mobile service: mobile service between aeronautical stations and aircraft stations, or between aircraft stations, in which survival craft stations may participate

conducted measurements: measurements which are made using a direct RF connection to the equipment under test

ground base station: aeronautical station equipment, in the aeronautical mobile service, for use with an external antenna and intended for use at a fixed location

radiated measurements: measurements which involve the measurement of a radiated field

3.2 Abbreviations

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

AF	Audio Frequency
AGC	Automatic Gain Control
AM	Amplitude Modulation
dBc	dB relative to the carrier power
DSB	Double Side Band
I/P	InPut
IF	Intermediate Frequency
O/P	OutPut
ppm	parts per million
RF	Radio Frequency
rms	root mean square
SINAD	(Signal + Noise + Distortion)/(Noise + Distortion)
VSWR	Voltage Standing Wave Ratio

4 General requirements

25 kHz equipment shall be able to operate on the frequencies 225,000 MHz to 399,975 MHz.

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

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

4.1 Controls and indicators

The equipment shall have the following controls and indicators as a minimum:

- a visual indication that the device is switched on;
- a facility to disable the squelch for test purposes;
- a visual indication that the carrier is being produced.

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.

4.2 Class of emission and modulation characteristics

The equipment shall use Double Side Band (DSB) Amplitude Modulation (AM) full carrier, 6K80A3EJN with 25 kHz channel spacing.

4.3 Warm up

After being switched on the equipment shall meet the requirements of the present document within one minute under normal test conditions (see clause 5.3).

If the equipment includes parts which require to be heated in order to operate correctly (e.g. crystal ovens) a warming-up period of 10 minutes of those parts shall be allowed.

5 Test conditions, power sources and ambient temperatures

5.1 Normal and extreme test conditions

Measurements shall be made under normal test conditions (see clause 5.3) and also, where stated, under extreme test conditions (see clauses 5.4.1 and 5.4.2).

5.2 Test power source

During testing, the equipment shall be supplied from a test power source capable of producing normal and extreme test voltages.

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

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

5.3 Normal test conditions

5.3.1 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: 20 % to 75 %.

When it is impracticable to carry out the tests under these conditions, a note to this effect, stating the ambient temperature and relative humidity during the tests, shall be added to the test report.

5.3.2 Normal power sources

5.3.2.1 Mains voltage and frequency

The normal test voltage for equipment to be connected to the mains shall be the nominal 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 was designed.

The frequency of the test power source corresponding to the AC mains shall be between 49 Hz and 51 Hz.

5.3.2.2 Other power sources

For operation from other power sources or types of battery (primary or secondary), the normal test voltage shall be that declared by the equipment manufacturer.

5.4 Extreme test conditions

5.4.1 Extreme temperatures

For tests at extreme temperatures, measurements shall be made in accordance with clause 5.5, at a lower temperature of -20 °C and an upper temperature of +55 °C. This test shall be performed at the nominal supply voltage as defined in clause 5.3.2.

5.4.2 Extreme values of test power sources

5.4.2.1 Mains voltage

The extreme test voltages shall be between 207 V and 253 V. This test shall be performed at the normal temperature and humidity as defined in clause 5.3.1.

The frequency of the test voltage shall be between 49 Hz and 51 Hz.

5.4.2.2 Other power sources

For equipment using other power sources, or capable of being operated from a variety of power sources, the extreme test voltages shall be those agreed between the equipment manufacturer and the testing laboratory and shall be recorded in the test report.

5.5 Performance test

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

- for the transmitter:
 - frequency error:
with the transmitter connected to a coaxial termination (see clause 6.2.1), the frequency error shall be as in clause 7.2;
 - carrier power:
with the transmitter connected to a coaxial termination (see clause 6.2.1), the transmitter shall be keyed without modulation and the output power shall be as defined in clause 7.3;
 - modulation:
with the transmitter connected to a coaxial termination (see clause 6.2.1), the transmitter shall be keyed. The modulation distortion shall be as in clause 7.4.3;
- for the receiver:
 - sensitivity:
with the AGC operative, a normal test signal (see clause 6.1.3) shall be applied to the receiver. The sensitivity shall be as defined in clause 8.1.

5.6 Environmental tests

5.6.1 General

Environmental tests shall follow checking the protection of the transmitter (see clause 7.1) which follows the first application of the Performance test (see clause 5.5).

5.6.2 Procedure for tests at extreme temperatures

Before tests at the upper extreme temperature ($55\text{ °C} \pm 3\text{ °C}$), the equipment shall be placed in the test chamber and left until thermal balance is attained. The equipment shall then be switched on for 30 minutes. The transmitter shall then be keyed for 1 minute in the transmit condition, after which the equipment shall meet the specified requirements. Transmitters shall be operated in the highest rated power transmit condition.

For tests at the lower extreme temperature ($-20\text{ °C} \pm 3\text{ °C}$), the equipment shall be left in the test chamber until thermal balance is attained, then switched to the standby or receive condition for 1 minute after which the equipment shall meet the specified requirements.

NOTE: It is assumed that equipment intended for off-set carrier operation will be installed in a building with facilities suitable to provide protection from temperature extremes, therefore extreme temperature tests need not be applied to such equipment.

5.6.3 Temperature tests

The chamber must be able to maintain the required temperature value during the measurement.

5.6.3.1 High temperature

- Place the equipment in a chamber and heat to the required temperature value and allow to stabilize for 1 hour.
- Switch on the equipment.
- After 30 minutes carry out the performance test as detailed in clause 5.5.
- Switch off the equipment and allow the chamber to cool to room temperature over a 1 hour period.
- Allow time for the equipment to stabilize to normal room temperature and humidity before carrying out the next test.

5.6.3.2 Low temperature

- Place the equipment in a chamber and cool to the required temperature value for 2 hours.
- Switch on the equipment and maintain the chamber at the required operating temperature.
- After 10 minute carry out the performance test as detailed in clause 5.5.
- Switch off the equipment and allow the chamber to rise to room temperature over a 1 hour period.
- Allow time for the equipment to stabilize to normal room temperature and for moisture to disperse before carrying out the next test.

6 General conditions of measurement

6.1 Receiver test signal arrangement

6.1.1 Test signal sources

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

6.1.2 Nominal frequency

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

6.1.3 Normal test signal

The normal test signal shall be a Double Side Band signal with carrier, amplitude modulated with 1 kHz sinewave to a depth of 30 %.

6.1.4 Squelch

Unless otherwise stated the receiver squelch facility shall be made inoperative for the duration of the tests.

6.1.5 Normal audio output power

The rated audio frequency output power is the value stated by the manufacturer to be the maximum power available at the output, for which all the requirements of the present document are met.

The audio frequency output power shall be maintained at 50 % of the rated output in the presence of a desired signal unless otherwise defined.

6.1.6 Audio AGC

When an audio AGC function is provided, this shall be disabled (where possible) unless otherwise stated.

6.2 Transmitter test signal arrangement

6.2.1 Coaxial termination

When tests are carried out with a coaxial termination, this shall be a non-reactive, non radiating 50 Ω load.

6.2.2 Signal sources

The modulating signals shall be applied to the transmitter through the modulating audio input.

6.2.3 Normal test signal

The normal test signal shall be a 1 kHz sinewave at a level which produces a 30 % amplitude modulation depth, of the transmitter RF output, unless otherwise defined.

6.3 Test channels

Tests shall be carried out on three frequencies unless otherwise stated:

- 225,000 MHz;
- 312,500 MHz;
- 399,975 MHz.

7 Transmitter

All tests on the transmitter shall be carried out at the maximum rated output power (see clause 7.3.1) except where otherwise stated.

7.1 Protection of the transmitter

7.1.1 Definition

The protection of the transmitter represents the ability of the transmitter to be protected against malfunction due to faults in the antenna system. This shall be the first test applied to a transmitter.

7.1.2 Method of measurement

While the transmitter is transmitting at the rated output power, the antenna port shall first be short-circuited and then open-circuited, in each case for a period of 1 minute. This test shall be performed on 312,5 MHz only.

7.1.3 Requirement

This test shall not result in any damage to the transmitter. After removal of the short-circuit and open-circuit conditions, the transmitter shall be able to operate normally when re-keyed.

7.2 Frequency error

7.2.1 Definition

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

7.2.2 Method of measurement

The carrier frequency shall be measured in the absence of modulation, with the transmitter connected to a coaxial termination (see clause 6.2.1). Measurements shall be made under normal test conditions (see clause 5.3) and under extreme test conditions on 312,5 MHz.

7.2.3 Limits

The frequency error shall be within the requirements of table 1.

Table 1

Frequency Error	Normal Temperature +15 °C to +35 °C	Extreme Temperature -20 °C to +55 °C
Fixed Base	±5 ppm	±10 ppm
2-carrier/3-carrier offset system	±5 ppm	N/A
4-carrier offset system	±1,2 ppm	N/A

NOTE: Offset carrier frequencies will be those defined in STANAG 4205 [4].

For 2-carrier, 3-carrier and 4-carrier offset systems the frequency shift values $\pm 7,5$ kHz, $\pm 5,0$ kHz, $\pm 2,5$ kHz and 0,0 kHz shall be used. The maximum allowed frequency deviation due to inaccuracy of the internal reference must be less than ± 8 kHz.

7.3 Carrier power

7.3.1 Definitions

The carrier power is the mean power delivered to the coaxial termination during transmission in the absence of modulation.

The requirements of the present document shall be met for all power output levels at which the transmitter is intended to operate into 50 Ω . For practical reasons measurements shall be performed only at the lowest and the highest power output level at which the transmitter is intended to operate, unless otherwise stated.

7.3.2 Method of measurement

The transmitter shall be connected to a coaxial termination (see clause 6.2.1) and the output power delivered to this coaxial termination shall be measured at the output connector. The measurements shall be made under normal test conditions (see clause 5.3) for the highest and lowest transmitter power output level and at the highest transmitter power output level under extreme test conditions as applicable.

Measurements shall be made on the test channels (see clause 6.3).

7.3.3 Tolerances

7.3.3.1 Normal test conditions

The carrier power measured under normal test conditions (see clause 5.3) with the output power adjusted to maximum, shall not vary by more than $\pm 1,5$ dB from the rated maximum output power.

7.3.3.2 Extreme test conditions

The carrier power measured under extreme test conditions (see clause 5.4) with the output adjusted to maximum rated power, shall not vary by more than +1,5 dB and -3 dB from the rated maximum output power.

7.4 Amplitude modulation characteristic

7.4.1 Modulation depth

7.4.1.1 Definitions

Amplitude modulation depth:

The amplitude modulation depth is the fractional ratio, expressed as a percentage, of the difference and the sum of the numerical values of the largest and smallest amplitudes encountered in one cycle of the modulating waveform.

Limiting threshold:

The limiting threshold is defined as the minimum audio input level required to produce the manufacturers declared modulation depth for the equipment (85 % minimum at 1 kHz).

7.4.1.2 Method of measurement

The normal 1 kHz test signal shall be applied to the modulation input of the transmitter. The test signal level shall then be set at a level 3 dB above the limiting threshold.

The modulation depth shall be measured at the output of the transmitter connected to a coaxial termination (see clause 6.2.1), by means of a modulation analyser.

7.4.1.3 Limits

The amplitude modulation depth shall be at least 85 % under normal temperature conditions and at least 80 % for extreme temperature measurements.

7.4.2 Modulation compression**7.4.2.1 Definition**

Modulation compression is the reduction of the modulation sensitivity at input signal levels above the limiting threshold determined in clause 7.4.1.

7.4.2.2 Method of measurement

The normal test signal of 1 kHz shall be applied to the modulation input of the transmitter tuned to 312,5 MHz.

The modulation depth shall be measured at the output of the transmitter connected to a coaxial termination (see clause 6.2.1), by means of a modulation analyser. Adjust the audio level applied to the modulation input to produce a modulation level of 30 %. Set the audio signal to produce modulation levels of 10 % and at the threshold that produces 85 %.

Confirm that when the level is varied between the values in table 2, the corresponding modulation depth changes are achieved within the stated tolerances.

With the audio input level set at the threshold that produces 85 % modulation, increase the level by 20 dB and record the maximum usable modulation depth.

7.4.2.3 Limits

The modulation shall be linear up to 85 % within ± 2 dB.

The maximum usable modulation depth shall not exceed 95 %.

Table 2

Level Increase	Modulation Change	Level Tolerance
10 dB	10 % to 30 %	± 2 dB
9 dB	30 % to 85 %	+1 dB/-2 dB

7.4.3 Amplitude modulation distortion**7.4.3.1 Definition**

The amplitude modulation distortion is the ratio of the total rms voltage of all the harmonics of the modulated waveform to the total rms voltage.

7.4.3.2 Method of measurement

The normal test signal of 1 kHz set at a level 3 dB above the limiting threshold determined in clause 7.4.1 shall be applied to the modulation input of the transmitter.

The modulation distortion shall be measured at the output of the transmitter connected to a coaxial termination (see clause 6.2.1), by means of a distortion analyser.

7.4.3.3 Limits

The amplitude modulation distortion shall be less than 10 %.

7.4.4 Audio frequency response

7.4.4.1 Definition

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

7.4.4.2 Method of measurement

The audio frequency response shall be measured at 312,5 MHz.

The Normal test signal (see clause 6.2.3) shall be applied to the transmitter input and the level adjusted to give a modulation depth of 60 %.

The modulation frequency shall be varied between 300 Hz and 5 kHz, with the level of the audio input test signal kept constant.

The modulation depth shall be measured at the output of the transmitter connected to a coaxial termination (see clause 6.2.1), by means of a modulation analyser. The results shall be expressed in dB relative to 1 kHz in tabular and/or graphical format.

7.4.4.3 Limits

The modulation depth as measured over the modulating frequency range of 300 Hz to 3,4 kHz shall be less than +2 dB and -4 dB (referred to 1 kHz).

At 5 kHz the modulation depth shall be at least -25 dB referred to 1 kHz.

7.5 Adjacent channel power

7.5.1 Definition

The adjacent channel power is that part of the total power output of a transmitter under defined conditions of modulation, which falls within a specified passband centered on the nominal frequency of either of the adjacent channels. This power is the sum of the mean power produced by the modulation, hum and noise of the transmitter.

7.5.2 Measurement

The adjacent channel power shall be measured with a power measuring receiver, or an equivalent analyser here referred to as the "measurement receiver", conforming to annex B:

- a) the transmitter shall be operated at the maximum carrier power determined in clause 7.3 under normal test conditions. The output of the transmitter shall be linked to the input of the " measurement receiver " by a connecting device such that the impedance presented to the transmitter is 50 Ω and the level at the "measurement receiver" input is appropriate;
- b) the transmitter shall be modulated with a signal at 1 kHz at a level required to produce a modulation depth of 85 %;
- c) with the transmitter modulated, the tuning of the "measurement receiver" shall be adjusted so that a maximum response is obtained. This is the 0 dB response point. The "measurement receiver" attenuator setting and the reading of the meter shall be recorded;
- d) the tuning of the "measurement receiver" shall be adjusted away from the carrier so that the "receiver" -6 dB response nearest to the transmitter carrier frequency is located at a displacement from the nominal carrier frequency of 17 kHz;
- e) the "measurement receiver" variable attenuator shall be adjusted to obtain the same meter reading as in step c) or a known relation to it;
- f) the ratio of adjacent channel power to carrier power is the difference between the attenuator settings in steps c) and e), corrected for any differences in the reading of the meter;
- g) the measurement shall be repeated with the "measurement receiver" tuned to the other side of the carrier.

7.5.3 Limits

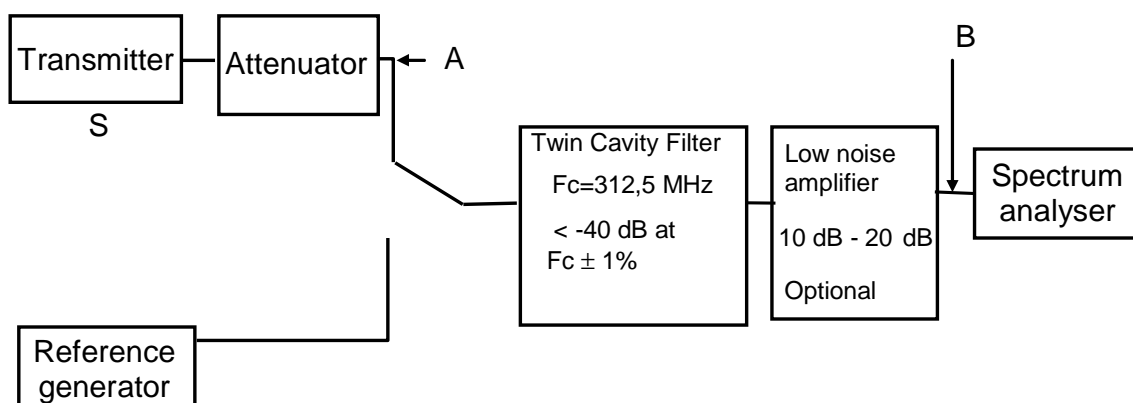
The adjacent channel power shall not exceed -60 dBc.

7.6 Broadband noise measurement

7.6.1 Definition

The broadband noise test determines the phase noise generated by the transmitter, (when keyed), between the adjacent channel and within the spurious emission exclusion band. It is necessary to minimize the effects of this noise in order to prevent desensitization of receivers operating on frequencies close to the transmitter.

7.6.2 Method of measurement



NOTE: Measurements shall be made at 312,5 MHz.

- Connect equipment as shown in figure 1.
- Initially connect the spectrum analyser to the attenuator output (point A). Set the transmitter to produce an unmodulated carrier at 312,5 MHz. Using a 50 kHz span and a 1 kHz bandwidth, note the output reference power (P_r).
- Reconnect the analyser to the filter output (point B) and connect the attenuator output to the cavity filter tuned to 312,5 MHz.
- Adjust the transmitter frequency to 313,5 MHz. Key the transmitter and apply modulation at 1 kHz at a level to give 85 % modulation depth. Monitor the noise level on the spectrum analyser. Use the analysers averaging function to find the mean level at 312,5 MHz in a 25 kHz bandwidth. Note this level as (P_m).
- De-key the transmitter and apply an unmodulated signal from the reference generator at 312,5 MHz. Increase the RF level until it is the same amplitude as the noise level noted above (P_m). Record this level as P_{mref} .
- The wide band noise at 1 MHz offset is then determined from the following formulae:

$$WB\ noise = P_{mref} + P_r + BW\ correction\ (dBc/Hz).$$
 where BW correction for 1 kHz = 30 dB.
 (For example if P_{mref} was -105 dBm and P_r = +10 dBm then the WB noise is $105 + 10 + 30 = 145$ dBc/Hz)
- Adjust the transmitter frequency to 311,5 MHz and repeat the test.

Figure 1: Broadband noise measurement

7.6.3 Limit

The broadband noise limit shall be: < -140 dBc/Hz.

7.7 Conducted spurious emissions

7.7.1 Definition

Conducted spurious emissions are RF emissions appearing at the RF output port 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. Conducted spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out of band emissions.

7.7.2 Method of measurement

- Conducted spurious emissions shall be measured with the unmodulated transmitter connected to the coaxial termination (see clause 6.2.1) and operating on the centre test frequency (see clause 6.3).
- The measurements shall be made over a range from 9 kHz to 4 GHz, excluding the channel on which the transmitter is operating and separated from the centre frequency of the emission by ± 1 MHz.
- The measurements for each spurious emission shall be made using a tuned radio measuring instrument or a spectrum analyser.
- The measurements shall be repeated with the transmitter in standby mode.

7.7.3 Limits

Table 3

Environmental phenomena	Frequency range	Units	Test limits, Tx Standby	Test limits Tx active mode	Reference bandwidth
Spurious conducted RF Emissions	9 kHz to 150 kHz	dBm	-57 (2 nW)	-46 dBm	B = 1 kHz
Spurious conducted RF Emissions	> 150 kHz to 30 MHz	dBm	-57 (2 nW)	-46 dBm	B = 9 kHz to 10 kHz
Spurious conducted RF Emissions	> 30 MHz to 1 GHz	dBm	-57 (2 nW)	-65 dBc for harmonics, -43 dBm for non-harmonic spurious	B = 10 kHz (see note)
Spurious conducted RF Emissions	> 1 GHz to 4 GHz	dBm	-47 (20 nW)	-70 dBc for harmonics -40 dBm for non-harmonic spurious	B = 10 kHz

NOTE: An exclusion band of ± 1 MHz about the carrier shall be used in active transmit mode.

NOTE: Cabinet radiation measurements do not appear in the present document. This aspect is replaced by applying the radiated emission test contained in the harmonized standard for VHF aeronautical equipment EN 301 489 [2]. The combination of applying the conducted spurious measurement above, and radiated measurements up to the 10th harmonic of the highest selectable frequency is considered sufficient to provide confidence that undesired emissions are adequately contained.

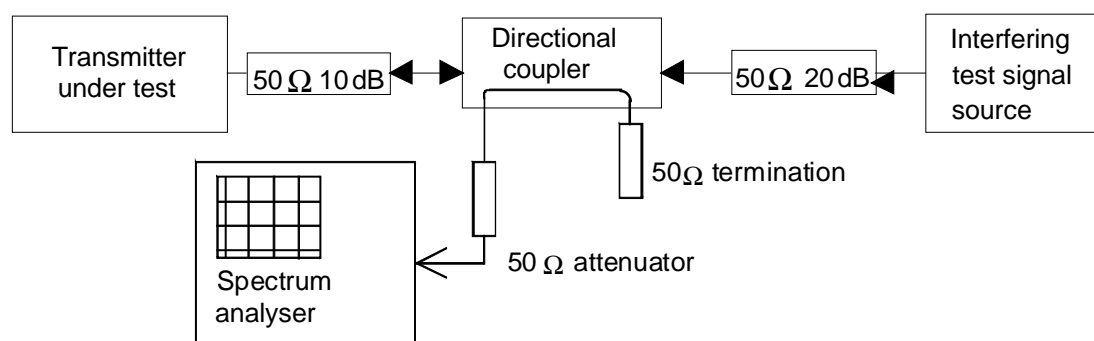
7.8 Intermodulation attenuation

7.8.1 Definition

Intermodulation attenuation is the capability of a transmitter to avoid the generation of signals in the non-linear elements caused by the presence of the carrier and an interfering signal entering the transmitter via the antenna.

It is specified as the ratio, in dB, of the power level of the third order intermodulation product to the carrier power level.

7.8.2 Method of measurement



NOTE:

- a) The measurement arrangement shown in figure 2 shall be used.
- b) The transmitter shall be connected to a 50 Ω, 10 dB power attenuator and via a directional coupler to a spectrum analyser. An additional attenuator may be required between the directional coupler and the spectrum analyser to avoid overloading the spectrum analyser.
- c) In order to reduce the influence of mismatch errors it is important that the 10 dB power attenuator is coupled to the transmitter under test with the shortest possible connection.
- d) The interfering test signal source is connected to the other end of the directional coupler via a 50 Ω, 20 dB power attenuator.
- e) The interfering signal source may be either a transmitter providing the same power output as the transmitter under test and be of a similar type or a signal generator and a linear power amplifier capable of delivering the same output power as the transmitter under test.
- f) The directional coupler shall have an insertion loss of less than 1 dB, a sufficient bandwidth and a directivity of more than 20 dB.
- g) The transmitter under test and the test signal source shall be physically separated in such a way that the measurement is not influenced by direct radiation.
- h) The transmitter under test shall be unmodulated and the spectrum analyser adjusted to give a maximum indication with a frequency scan width of 500 kHz.
- i) The interfering test signal source shall be unmodulated and the frequency shall be within 150 kHz to 200 kHz above the frequency of the transmitter under test.
- j) The frequency shall be chosen in such a way that the intermodulation components to be measured do not coincide with other spurious components.
- k) The power output of the interfering test signal source shall be adjusted to the carrier power level of the transmitter under test by the use of a power meter.
- l) The intermodulation component shall be measured by direct observation on the spectrum analyser and the ratio of the largest third order intermodulation component to the carrier recorded.
- m) This measurement shall be repeated with the interfering test signal source at a frequency within 150 kHz to 200 kHz below the frequency of the transmitter under test.

Figure 2: Measurement arrangement

7.8.3 Limits

The intermodulation protection ratio shall be at least 40 dB.

7.9 RF power attack time and release time

7.9.1 Definitions

The transmitter power attack time (t_a) is the time which elapses between:

- $t_{on L}$: defined by the condition when the transmitter output power, measured at the antenna terminal, exceeds -20 dBc;
- $t_{on H}$: defined by the condition when the transmitter output power has reached -1,5 dBc.

The transmitter release time (t_r) is the time which elapses between:

- $t_{\text{off H}}$: defined by the condition when the transmitter output power falls below -1,5 dBc;
- $t_{\text{off L}}$: defined by the condition when the transmitter output power has reached -20 dBc.

The measured value of t_a and t_r are respectively t_{am} (transmitter attack measurement) and t_{rm} (transmitter release measurement), the limits are respectively t_{al} and t_{rl} .

7.9.2 Method of measurement

7.9.2.1 Attack time

The following method of measurement shall be used:

- a) the transmitter is connected to a RF detector via a matched test load. The attenuation of the test load shall be chosen in such a way that the input of the RF detector is protected against overload and the detector operates as soon as the transmitter is keyed:
 - a dual trace storage oscilloscope (or a transient recorder) records the amplitude transient from the detector on a logarithmic scale;
 - a trigger device may be required to ensure that the start of the sweep of the oscilloscope timebase occurs the instant at which the "transmitter $t_{\text{on L}}$ " function is initiated;
 - a spectrum analyser can also be used;
- b) the traces of the oscilloscope shall be calibrated in power (y-axis) and in time (x-axis), using the signal generator;
- c) the transmitter attack time shall be measured by direct reading on the oscilloscope while the transmitter is unmodulated and transmitting on 312,5 MHz.

7.9.2.2 Release time

The following method of measurement shall be used:

- a) the transmitter is connected to a RF detector via a matched test load. The attenuation of the test load shall be chosen in such a way that the input of the RF detector is protected against overload and the detector operates as soon as the transmitter is keyed:
 - a dual trace storage oscilloscope (or a transient recorder) records the amplitude transient from the detector on a logarithmic scale;
 - a trigger device may be required to ensure that the start of the sweep of the oscilloscope timebase occurs the instant at which the "transmitter $t_{\text{off H}}$ " function is de-activated;
 - a spectrum analyser can also be used;
- b) the traces of the oscilloscope shall be calibrated in power (y-axis) and in time (x-axis), using the signal generator;
- c) the transmitter release time shall be measured by direct reading on the oscilloscope while the transmitter is unmodulated and transmitting on 312,5 MHz.

7.9.3 Limits

- t_{al} shall be < 20 ms;
- t_{rl} shall be < 10 ms.

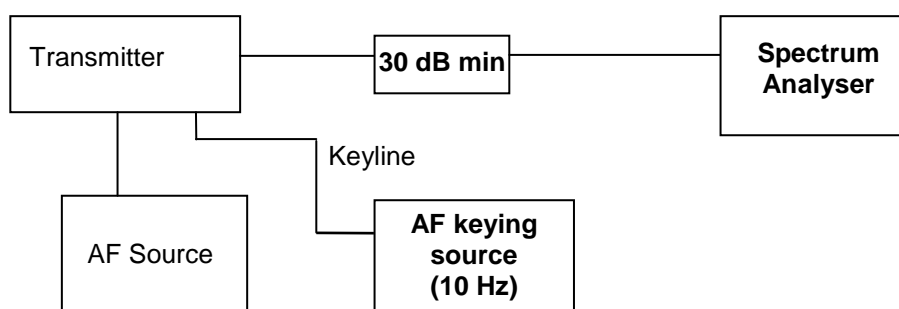
- The keying time (the period from the initial keying signal to the point when the transmitter produces 90 % of the transmit power) shall be < 50 ms.

7.10 Keying Transient frequency behaviour of the transmitter

7.10.1 Definitions

The transient frequency behaviour of the transmitter due to the wide-band spectral response caused by switching of the keyline.

7.10.2 Method of measurement



NOTE:

- The transmitter shall be connected via a 50 Ω power attenuator, capable of reducing the RF power to a safe level for the spectrum analyser.
- The transmitter shall be set to 225 MHz and be modulated by a 1 kHz tone to produce a modulation depth of 85 %.
- The analyser shall be adjusted to the nominal frequency of the transmitter and the span adjusted to 100 kHz with a 1 kHz bandwidth.
- The transmitter shall be keyed and the spectrum analyser settings adjusted to display a centre frequency response at the reference level (using maximum hold function), with at least 60 dB dynamic range.
- The transmitter Keyline shall then be controlled by a suitable switching signal which shall allow the transmitter to be keyed at a rate of at least 5 Hz.
- The analyser shall be set to maximum hold and the keyline switched at the above rate for at least 2 minutes.
- The analyser display shall be recorded.
- Repeat for all test channels (see clause 6.3).

Figure 3: Measurement arrangement

7.10.3 Limits

The transients shall be at least 30 dB below the reference level at frequencies separated from the carrier by more than 10 kHz.

7.11 Sidetone

Where airband transceivers provide a locally derived side-tone for monitoring and recording purposes the sidetone signal may be derived either internally or through a carrier derived audio signal.

The sidetone level shall be measured whilst transmitting on 312,5 MHz. The normal 1 kHz test signal shall be applied to the speech modulation input of the transmitter. The test signal level shall then be set at a level 3 dB above the minimum level that produces a modulation depth of 30%.

The rms sidetone output shall be terminated in a resistive load defined by the manufacturer. The modulation distortion shall be measured by means of a distortion analyser.

7.11.1 Limits

The amplitude modulation distortion shall be less than 10 %.

8 Receiver

8.1 Sensitivity

8.1.1 Definition

The sensitivity of the receiver is the level of the signal at the nominal frequency of the receiver which, when applied to the receiver input with normal test modulation (see clause 6.1.3), produces:

- in all cases, an audio frequency output power not less than 50 % of the rated output power (see clause 6.1.5); and
- a SINAD ratio of 12 dB, measured at the receiver output using a psophometric telephone filtering network as described in ITU-T Recommendation O.41 [1].

8.1.2 Method of measurement

- a) A normal test signal (see clause 6.1.3) at a carrier frequency equal to the nominal frequency of the receiver shall be applied to the receiver input. An audio frequency load and a measuring instrument for measuring the SINAD ratio (through a psophometric network) shall be connected to the receiver output terminals.
- b) The level of the test signal shall be adjusted until a SINAD ratio of 12 dB is obtained, using the psophometric network and with the receiver's audio power control adjusted to produce 50 % of the rated output power. Under these conditions, the level of the test signal at the input is the value of the maximum sensitivity.
- c) The measurements shall be made under normal test conditions (see clause 5.3) and under extreme test conditions as applicable.
- d) A receiver output power variation of ± 3 dB relative to 50 % of the rated output power may be allowed for sensitivity measurements under extreme test conditions. The measurements shall be performed on all test channels (see clause 6.3).

8.1.3 Limits

The maximum sensitivity shall not exceed -101 dBm under normal test conditions and -95 dBm under extreme test conditions as applicable.

8.2 Harmonic distortion

8.2.1 Definition

The harmonic distortion at the receiver output is defined as the ratio, expressed as a percentage, of the total rms voltage of all the harmonic components of the modulation audio frequency to the total rms voltage of the signal delivered by the receiver.

8.2.2 Method of measurement

- a) The normal test signal (see clause 6.1.3) shall be applied at the centre test frequency (equal to the nominal frequency of the receiver), at levels of -53 dBm and -13 dBm. The signal shall be applied in succession to the receiver input under the normal test conditions specified in clause 5.3.
- b) AF AGC shall be switched off where possible.

- c) The audio distortion shall be measured for test signals producing 30 % (normal) and 90 % modulation levels.
- d) The audio input to the distortion meter shall be adjusted to produce 50 % of the rated output power for each test.

8.2.3 Limits

The harmonic distortion shall not exceed 5 % at 30 % modulation depth and 10 % at 90 % modulation depth.

8.3 Audio frequency response

8.3.1 Definition

The audio frequency response expresses the ability of the receiver to operate without excessive degradation of its frequency response as a function of the audio frequency.

8.3.2 Method of measurement

The audio frequency response shall be measured on 312,5 MHz.

- a) A test signal (see clause 6.1) at a level of -53 dBm at a carrier frequency equal to the nominal frequency of the receiver shall be applied to the receiver input under normal test conditions specified in clause 5.3.
- b) AF AGC shall be switched off.
- c) The audio frequency shall then be varied between 300 Hz and 3,4 kHz, with the level of the test signal being kept constant and equal to the value specified above.
- d) Where a separate data output exists the response shall also be measured at this port.

8.3.3 Limits

The audio output level shall not vary by more than +2 dB and -4 dB within the frequency range of 300 Hz to 3,4 kHz.

8.4 Audio noise

8.4.1 Definition

The audio noise is defined as the ratio, in dB, of the audio-frequency power of the noise to the audio-frequency power produced by the normal test signal (see clause 6.1) applied to the receiver input weighted according ITU-T Recommendation O.41 [1].

8.4.2 Method of measurement

- a) A test signal (see clause 6.1) at a level of -13 dBm at 312,5 MHz shall be applied to the receiver input under normal test conditions specified in clause 5.3. Modulation depth shall be set at 90 %.
- b) The audio output level shall be set to the rated output power for the output under test (loudspeaker, headset, line output). A resistive load modelling the normal audio output load shall be connected.
- c) The output signal including noise (S + N) shall be measured by a rms voltmeter and recorded.
- d) Then the modulation of the test signal shall be switched off and the audio-frequency output level (N) shall be measured.

The measurements shall be made using psophometric filtering network, ITU-T Recommendation O.41 [1].

8.4.3 Limits

The ratio $(S + N)/N$ shall be better than 40 dB.

8.5 Effective acceptance bandwidth

8.5.1 Definition

The effective acceptance bandwidth is the frequency range over which an applied signal shall not be rejected by the receiver. This bandwidth allows the reception of offset carriers.

8.5.2 Method of measurement

A test signal (see clause 6.1.3) at 312,5 MHz at a RF level necessary to achieve a 12 dB SINAD via a psophometric filter, shall be applied to the receiver input under normal test conditions (see clause 5.3). The RF signal shall then be increased by 6 dB.

The test signal frequency shall be varied $\pm 8,5$ kHz from the nominal carrier frequency of the receiver with the test signal amplitude being kept constant and equal to the value specified above.

8.5.3 Limits

The SINAD ratio shall be > 12 dB. The test signal frequency shall be at least $\pm 8,5$ kHz from the nominal carrier frequency.

NOTE: For receivers intended for use with 3 and 4 offset channels a 6 dB point of ± 11 kHz is recommended.

8.6 Adjacent channel rejection

8.6.1 Definition

The adjacent channel rejection is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal which differs in frequency from the wanted signal by 25 kHz as appropriate.

8.6.2 Method of measurement

- a) Measurements shall be made on the test channels (see clause 6.3)
- b) The two input signals from signal generators G1 and G2 shall be applied to the receiver input via a combining network. An audio analyser shall be connected to the receiver output terminals via a psophometric filter.
- c) With the output of G2 switched off, the wanted test signal from G1 at the receive frequency, shall be set to produce a modulation depth of 60 % at 1 kHz.
- d) Adjust the level of G1 to achieve a SINAD of 12 dB at the receiver output terminals.
 - This shall be recorded as Level 1.
- e) Repeat the measurement but this time switch off G1 and adjust G2, modulated 60 % at 1 kHz, to achieve a SINAD of 12 dB at the receiver output terminals.
 - This shall be recorded as Level 2.
- f) Switch on generator G1. Set G2 to a frequency of one channel separation above the nominal frequency of the receiver and apply modulation at 400 Hz with 60 % modulation depth.

- g) The amplitude of the unwanted signal shall be adjusted until the SINAD ratio at the output of the receiver is reduced to 6 dB.
 - Record this level as Level 3.
- h) The upper adjacent channel rejection is the difference between Level 3 and Level 2.
- i) The measurement shall be repeated with the unwanted signal (G2) on the channel below that of the wanted signal.
- j) For the upper and lower adjacent channel measurements the minimum difference shall be recorded as the adjacent channel rejection.

8.6.3 Limits

The adjacent channel rejection shall be greater than 60 dB.

8.7 Spurious response rejection

Spurious responses may occur at all frequencies throughout the frequency spectrum and the requirements of the present document shall be met for all frequencies. However, for practical reasons the measurements for type testing shall be performed as specified in the present document. More specifically, this method of measurement is not intended to capture all spurious responses but selects those that have a high probability of being present. However, in a limited frequency range close to the nominal frequency of the receiver, it has been considered impossible to determine the probability of a spurious response and therefore a search shall be performed over this limited frequency range. This method provides a high degree of confidence that the equipment also meets the requirements at frequencies not being measured.

8.7.1 Definition

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

8.7.2 Introduction to the method of measurement

To determine the frequencies at which spurious responses can occur the following calculations shall be made:

- a) calculation of the "limited frequency range":
 - the limited frequency range is defined as the frequency of the local oscillator signal (f_{LO}) applied to the first mixer of the receiver plus or minus the sum of the intermediate frequencies (if₁...if_n) and a half of the maximum frequency range (f_m) of the receiver.

hence the limited frequency range = $f_{LO} \pm (if_1 + if_2 + \dots + if_n + f_m / 2)$

NOTE: For equipment employing a first intermediate frequency of > 100 MHz the upper limit of the limited frequency range shall be 400 MHz.

- b) calculation of frequencies outside the limited frequency range:
 - the frequencies outside the limited frequency range determined in a) are equal to the harmonics of the frequency of the local oscillator signal (f_{LO}) applied to the first mixer of the receiver plus or minus the first intermediate frequency (f_{i1}) of the receiver;
 - hence the frequencies of these spurious responses are $nf_{LO} \pm f_{i1}$, where n is an integer greater than or equal to 2;
 - the measurement of the first image response of the receiver shall initially be made to verify the calculation of spurious response frequencies.

For calculations a) and b), the manufacturer shall state the frequency of the receiver, the frequency of the local oscillator signal (f_{LO}) applied to the first mixer of the receiver, the intermediate frequencies (f_{i1} , f_{i2} , etc.), and the maximum frequency range (fr_m) of the receiver.

8.7.3 Method of search of the limited frequency range

- a) The normal test signal shall be applied (see clause 6.1.3).
- b) The test signal shall be adjusted to a level corresponding to a SINAD ratio of 12 dB via a psophometric filter and recorded as the reference level.
- c) The input level of the test signal shall then be adjusted to 80 dB above the reference level.
- d) The frequency shall be varied continuously over the limited frequency range determined in clause 8.7.2 a) and over the frequencies outside the frequency range in accordance with the calculations in clause 8.7.2 b).
- e) The frequency of any spurious responses detected during the search shall be recorded for the use in the measurement described in the following clause.

8.7.4 Method of measurement

- a) The test signal from a signal generator shall be applied to the receiver input. An rms voltmeter shall be connected to the receiver output via a psophometric filter.
- b) The test signal shall be a normal test signal (see clause 6.1.3) at the nominal frequency of the receiver.
- c) The RF signal level shall be adjusted to produce a SINAD ratio of 12 dB, and the RF level recorded as the reference level.
- d) The signal generator shall then be tuned to a spurious response frequency detected according to clause 8.7.3 and modulated with normal test modulation.
- e) The level of the RF signal is increased until the receiver output signal produces an SINAD ratio of 12 dB.
- f) This RF signal level shall be recorded as the unwanted signal level.
- g) The spurious response rejection ratio is the ratio in dB of the unwanted signal level to the reference level.
- h) This measurement shall be made for each frequency detected according to clause 8.7.3.

8.7.5 Limit

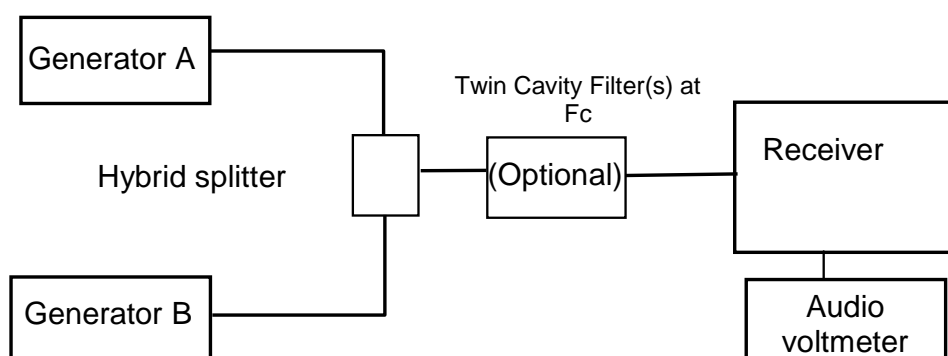
At any frequency separated from the nominal frequency of the receiver by more than two channels, the spurious response rejection ratio shall be not less than 70 dB.

8.8 Intermodulation response rejection

8.8.1 Definition

The intermodulation response rejection is the capability of a receiver to receive a wanted modulated signal at the nominal frequency, without exceeding a given degradation due to the presence of two or more unwanted signals with a specific frequency relationship to the wanted signal frequency.

8.8.2 Method of measurement



- a) Connect the equipment as shown and if used, adjust the cavity filters for minimum loss at the receiver channel frequency.
- b) The wanted signal from signal generator A, at the nominal frequency and producing a normal test signal (see clause 6.1.3) shall be applied to the input of the receiver via a combining network.
- c) The unwanted signal from signal generator B, at the frequency 100 kHz above the nominal frequency of the receiver and without modulation shall be applied to the receiver via the second input of the combining network.
- d) An rms voltmeter shall be connected to the receiver output via a psophometric filter.
- e) With the unwanted signal switched off, the level of the wanted signal shall be set to -53 dBm and the receiver volume control adjusted to obtain approximately 50 % of the rated audio output power.
- f) The level of the wanted signal shall be reduced until a 12 dB SINAD ratio is obtained.
- g) The level of the wanted signal under these conditions shall be recorded (x).
- h) The frequency of the wanted signal shall then be changed to a frequency of 200 kHz above the nominal frequency of the receiver. This signal now constitutes the second unwanted signal.
- i) The level of the two unwanted signals shall be kept equal and increased in level until a 12 dB SINAD ratio is again obtained. If necessary the frequency of either signal shall be varied slightly to obtain the maximum value of this ratio, their levels being re-adjusted to restore the 12 dB SINAD ratio.
- j) The level of the two signals under these conditions shall be recorded (y).
- k) The ratio, in dB, of the levels of the unwanted signals (y) to that recorded for the wanted signal (x) is the intermodulation response rejection ratio.
- l) These measurements shall be made on both sides of the nominal frequency.

Figure 4: Measurement arrangement

8.8.3 Limit

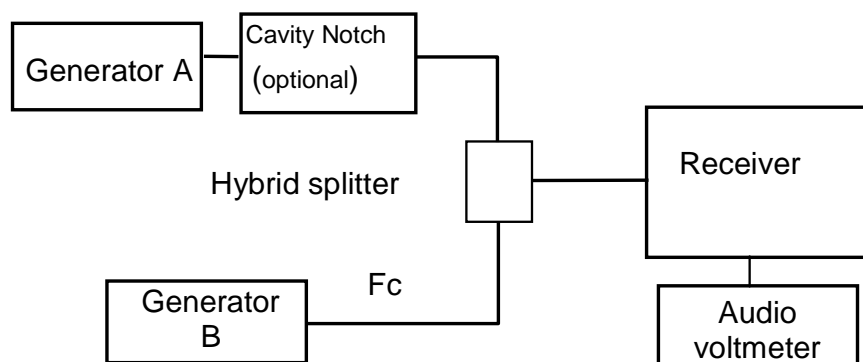
The intermodulation response rejection ratio shall be > 70 dB.

8.9 Blocking or desensitization

8.9.1 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.

8.9.2 Method of measurement



NOTE: For high performance base stations it may not be possible to measure the true blocking without the use of a cavity notch in the interfering path.

- a) Two input signals shall be applied to the receiver via a combining network. A cavity notch filter at the receiver frequency may be used to improve the noise performance of the test equipment. An rms voltmeter shall be connected to the receiver output terminals via a psophometric filter.
- b) The wanted normal test signal (see clause 6.1.3), at the nominal frequency, and at the sensitivity level (see clause 8.1) of the receiver shall be applied to the receiver input connector via one of the inputs of the combining network (Generator B).
- c) Where available, the receiver volume control shall be adjusted to give at least 50 % of the rated output power (see clause 6.1.5).
- d) The unwanted signal shall be unmodulated and the frequency shall be +1 MHz and -1 MHz relative to the nominal frequency of the receiver. The input level of the unwanted signal shall be adjusted until:
 - 1) the audio output level of the wanted signal is reduced by 3 dB; or
 - 2) the SINAD ratio, psophometrically weighted, at the receiver output is reduced to 6 dB.
- e) The measure of the blocking or desensitization is the ratio in dB of the level of the unwanted test signal to the level of the wanted test signal at the receiver input for which the specified reduction in audio output level or SINAD ratio occurs.
- f) The measurements shall be made on 312,5 MHz.

Figure 5: Measurement arrangement

8.9.3 Limit

The blocking ratio, for any frequency within the specified ranges, shall not be less than 80 dB.

8.10 Conducted spurious emissions

8.10.1 Definition

Conducted spurious emissions from the receiver are signals at any frequency, emitted from the antenna port. The level of spurious radiation shall be measured by their power level at the antenna connector.

8.10.2 Method of measuring the power level

Spurious radiation shall be measured as the power level of any discrete signal at the RF input terminal of the receiver. Connect the receiver input terminal to a spectrum analyser or selective voltmeter having an input impedance of 50 Ω and switch the receiver on.

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

The measurements shall extend over the frequency range of 9 kHz to 4 GHz.

8.10.3 Limits

The power of any conducted spurious emission shall not exceed the values given in table 4.

Table 4

Environmental phenomena	Frequency range	Units	Test limits Rx	Reference bandwidth
Spurious conducted RF Emissions	9 kHz to 150 kHz	dBm	-57 (2 nW)	B = 1 kHz
Spurious conducted RF Emissions	> 150 kHz to 30 MHz	dBm	-57 (2 nW)	B = 9 kHz to 10 kHz
Spurious conducted RF Emissions	> 30 MHz to 1 GHz	dBm	-57 (2 nW) (see note)	B = 100 kHz to 120 kHz
Spurious conducted RF Emissions	> 1 GHz to 4 GHz	dBm	-47 (20 nW)	B = 1 MHz
NOTE: Spurious limit -81 dBm, with a reference bandwidth of 10 kHz, for ground base station equipment in the band 225 MHz to 399,975 MHz.				

8.11 Squelch operation

8.11.1 Definition

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

8.11.2 Method of measurement

A signal generator shall be connected to the receiver input:

- a) Squelch mute attenuation:
 - The signal generator shall be set to produce a normal test signal (see clause 6.2.3) at the nominal frequency of the receiver at a level of -53 dBm. The audio output of the receiver shall be measured by an rms voltmeter connected to the receiver through a psophometric filter and shall be adjusted to approximately half the rated output power (see clause 6.1.5). With the signal generator-RF switched off and the squelch muting, the audio output shall be measured again. The difference between these two values is the squelch mute attenuation.
- b) Squelch hysteresis:
 - The signal generator shall be set to produce a normal test signal (see clause 6.1.3). The squelch operating point shall be set to the 12 dB SINAD point. Increase the RF output of the signal generator until the squelch circuit opens and note the corresponding RF level. Decrease the output of the signal generator until the squelch circuit mutes the audio output and note that RF level. The difference between the two recorded levels is the squelch hysteresis.
 - The squelch threshold setting range shall be from below the receiver sensitivity level (see clause 8.1) and the squelch function shall be deselectable.
 - The squelch facility shall be measured on the Test Channels (see clause 6.3).

8.11.3 Limits

Under the conditions specified in clause 8.11.2 a), the squelch mute attenuation shall be at least 60 dB.

Under the conditions specified in clause 8.11.2 b), the squelch hysteresis shall be within +1 dB and +6 dB.

Carrier override shall operate at levels > -85 dBm.

8.12 Cross modulation rejection

8.12.1 Definition

Cross modulation is the transposition of the AM component from a strong unwanted signal to the wanted signal.

Cross modulation rejection is the level difference between an unwanted signal and the maximum sensitivity level (as defined in clause 8.1) at the point where the audio component due to cross modulation tone reduces the SINAD ratio of the wanted signal to 20 dB.

8.12.2 Method of measurement

NOTE 1: For high performance base stations it may not be possible to measure the true cross modulation without the use of a cavity notch in the interfering path (see clause 8.9.2 for test arrangement).

- a) The two input signals shall be connected to the receiver via combining network. A cavity notch filter at the receiver frequency may be used to improve the noise performance of the test equipment. An rms voltmeter shall be connected to the receiver output terminals via a psophometric filter.
- b) The wanted signal, a normal test signal (see clause 6.1.3) at the nominal frequency of the receiver, shall be applied to the receiver input connector via one of the inputs of the combining network. The level of the signal will be set to produce a 30 dB SINAD ratio measured at the receiver output using a psophometric telephone filtering network as described in ITU-T Recommendation O.41 [1].
- c) The unwanted signal at a frequency offset of 1 MHz with respect to the nominal frequency of the receiver and amplitude modulated with 400 Hz at a depth of modulation of 30 % shall be applied to the second input of the combining network.
- d) The RF output level of the unwanted signal shall be increased until the 400 Hz tone reduces the SINAD ratio of the wanted signal to 20 dB.

NOTE 2: The interfering source should be a low noise generator, otherwise additional filtering of the RF signal may be required to prevent wideband noise masking the measurement.

- e) The ratio between this RF level of the unwanted signal and the maximum sensitivity (as defined in clause 8.1) is the cross modulation rejection.
- f) The measurement shall be repeated for an interfering signal at -1 MHz with respect to the nominal frequency of the receiver.
- g) This test shall be performed at 312,5 MHz.

8.12.3 Limits

The cross modulation rejection ratio shall be at least 80 dB.

8.13 Receiver dynamic range

8.13.1 Definition

The receiver dynamic range expresses the capability of the receiver to limit the resulting audio output as a function of varying input signal levels.

8.13.2 Method of measurement

A normal test signal (see clause 6.1.3) at 312,5 MHz with a level equal to the limit of the maximum sensitivity (see clause 8.1) shall be applied to the receiver under normal test conditions (see clause 5.3). The resulting audio output shall be measured by an AF power meter connected to the receiver and the value noted. The RF input level shall then be increased by 100 dB and the AF output level shall again be noted.

8.13.3 Limit

The RF automatic gain control shall process an input level change of 100 dB with respect to the limit of the maximum sensitivity level to less than 6 dB resulting audio output power changes.

8.14 AGC attack time and release time

8.14.1 Definitions

The time taken for the audio output to reach 90 % of its steady state value after a 40 dB step application of the input signal.

8.14.2 Method of measurement

8.14.2.1 Attack time

The following method of measurement shall be used:

- a) the receiver antenna port is connected to the signal generator output via a switchable 40 dB attenuator.
- b) the receiver output lines are monitored on a storage oscilloscope.
- c) apply an on channel signal at 312,5 MHz (mid-band test frequency) at a level of -47 dBm, modulated 30 % at 1 kHz, to the attenuator such that a -87 dBm signal is received at the receiver antenna port.
- d) switch out the attenuator and record the time taken for the audio output to settle to 100 % \pm 10 % of its steady state level.

A trigger device may be required to ensure that the start of the sweep of the oscilloscope timebase occurs the instant at which the attenuator is switched out.

8.14.2.2 AGC Decay time

The following method of measurement shall be used:

- a) the receiver antenna port is connected to the signal generator output via a switchable 40 dB attenuator;
- b) the receiver data output lines are monitored on a storage oscilloscope;
- c) apply an on channel signal at 312,5 MHz (mid-band test frequency) at a level of -47 dBm, modulated 30 % at 1 kHz, to the switchable attenuator, which should be switched out so that a -47 dBm signal is received at the receiver antenna port;
- d) switch in the attenuator and record the time taken for the audio output to settle to 100 % \pm 10 % of its steady state level and stay within this tolerance.

A trigger device may be required to ensure that the start of the sweep of the oscilloscope timebase occurs the instant at which the attenuator is switched in.

8.14.3 Limits

AGC attack time shall be < 40 ms.

AGC decay time shall be < 250 ms.

NOTE: The above test method and limits assume an analogue AM radio where a change in the input signal level results in an immediate change in the audio output. In the case of a digital radio where the intermediate frequency is resolved using digital signal processing, a processing delay occurs between the I.F input and the demodulated audio output.

Consequently, the measurement procedure defined in clause 8.14.2 results in a measurement time equal to the AGC time constant plus the radio's processing delay. This needs to be taken into account when considering whether the equipment meets the specification limit (clause 8.14.3).

8.15 AF AGC

8.15.1 Definition

The AF AGC expresses the capability of the receiver to limit the resulting audio output as a function of varying input modulation depths.

8.15.2 Method of measurement

A normal test signal (see clause 6.1.3) modulated at 60 % on 312,5 MHz and at a level of -53 dBm shall be applied to the receiver under normal test conditions (see clause 5.3). The resulting audio output shall be measured by an AF power meter connected to the receiver and the value noted. The modulation depth of the RF input shall then be varied between 30 % and 90 % and the AF output level shall again be noted.

8.15.3 Limit

Where an AF automatic gain control is fitted, the control shall compress an input modulation depth variation of 30 % to 90 % to an audio output power change of 1,5 dB or less.

9 Measurement uncertainty and interpretation of the measured results

The results of the measurement shall be recorded in the test report.

The measurement uncertainties shall be calculated by the test laboratory performing the measurements and shall also be recorded in the test report.

9.1 Maximum measurement uncertainties

The measurement uncertainties shall be better than or equal to those given in tables 5 and 6.

Table 5: Transmitter measurement uncertainty: maximum values

Measurement uncertainties	Maximum values
Frequency error	$\pm 1 \times 10^{-9}$
Carrier power (normal and extreme test conditions)	$\pm 0,75$ dB
Modulation depth	± 3 %
Modulation compression	± 3 %
Amplitude modulation distortion	± 3 %
Audio frequency response	± 2 dB
Adjacent channel power	$\pm 2,5$ dB
Conducted spurious emissions:	
- below 1 GHz	± 3 dB
- between 1 GHz and 4 GHz	± 6 dB
Transient frequency behaviour	± 250 Hz
Intermodulation	± 3 dB
RF power attack and release times	± 20 % of the limits values
Keying transient frequency behaviour	± 3 dB

Table 6: Receiver measurement uncertainty: maximum values

Measurement uncertainties	Maximum values
Receiver sensitivity	±3 dB
Harmonic distortion	±0,5 dB
Audio frequency response	±2 dB
Audio noise level	±3 dB
Effective acceptance bandwidth	±3 dB
Adjacent channel rejection	±4 dB
Spurious response rejection	±4 dB
Intermodulation response rejection	±3 dB
Blocking and desensitization	±4 dB
Conducted spurious radiation:	
- below 1 GHz	±3 dB
- between 1 GHz and 4 GHz	±6 dB
Squelch operation	±3 dB
Cross modulation rejection	±4 dB
Receiver dynamic range	±2 dB
50 Ω VSWR	1:1,2
AF AGC	±0,5

For the test methods according to the present document the uncertainty figures are valid to a confidence level of 95 % calculated according to the methods described in TR 100 028 [3].

9.2 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 measurement uncertainty value for the measurement of each parameter shall be included in the test report;
- the recorded value of the measurement uncertainty shall be, for each measurement, equal to or lower than the values in tables 5 and 6 (tables of measurement uncertainties).

Annex A (normative): Auxiliary cables

The position of auxiliary cables (power supply and microphone cables, etc.) which are not adequately decoupled may cause variations in the measuring results. In order to get reproducible results, cables and wires of auxiliaries should be arranged vertically downwards (through a hole in the non-conducting support).

Annex B (informative): Specification for adjacent channel power measurement arrangements

B.1 Power measuring receiver specification

The power measuring receiver consists of a mixer, an Intermediate Frequency (IF) filter, and oscillator, an amplifier, a variable attenuator and an rms value indicator. Instead of the variable attenuator with the rms value indicator it is also possible to use an rms voltmeter calibrated in dB. The technical characteristics of the power measuring receiver are given below.

B.1.1 IF filter

The IF filter shall be within the limits of the following selectivity characteristics.

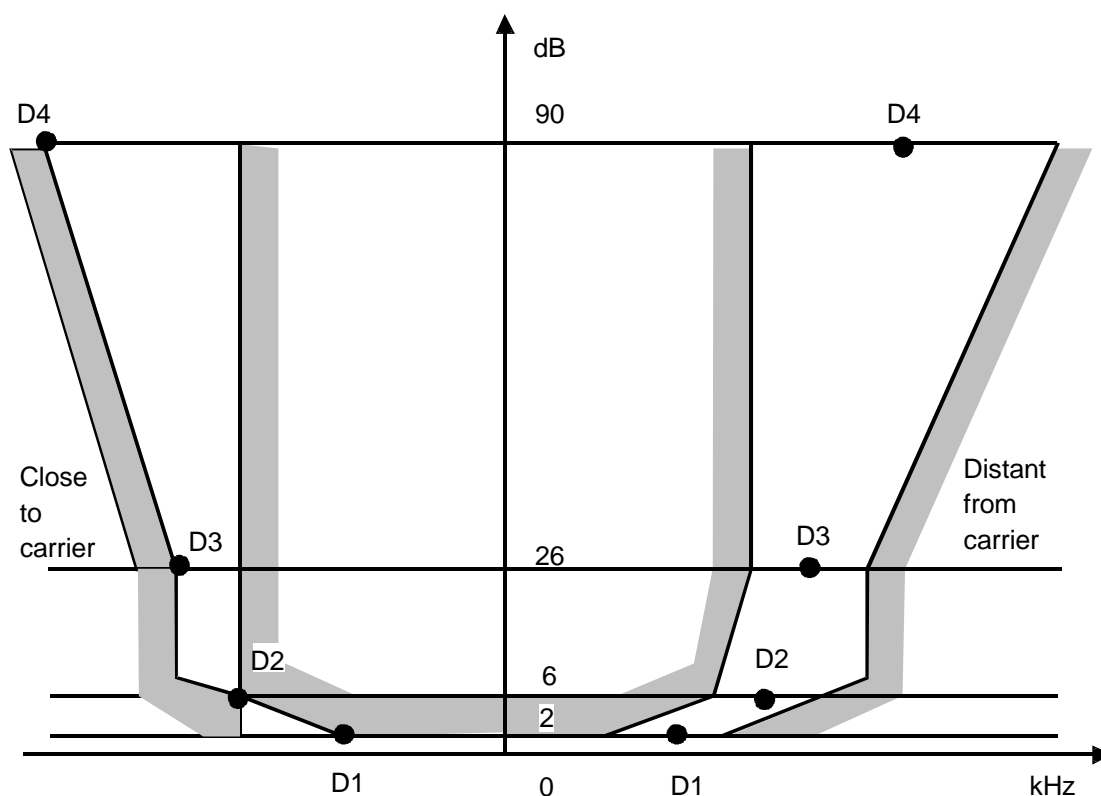


Figure B.1: Limits of the selectivity characteristic

The selectivity characteristic shall keep the following frequency separations from the nominal centre frequency of the adjacent channel:

Table B.1: Selectivity characteristic

Frequency separation of filter curve from nominal centre frequency of adjacent channel (kHz)				
	D1	D2	D3	D4
25 kHz Spacing	5	8	9,25	13,25

The attenuation points shall not exceed the following tolerances:

Table B.2: Attenuation points close to carrier

Tolerance range (kHz)				
	D1	D2	D3	D4
25 kHz Spacing	3,1	±0,1	-1,35	-5,35

Table B.3: Attenuation points distant from the carrier

Tolerance range (kHz)				
	D1	D2	D3	D4
25 kHz Spacing	±3,5	±3,5	±3,5	+3,5/-7,5

The minimum attenuation of the filter outside the 90 dB attenuation points shall be equal to or greater than 90 dB.

B.1.2 Attenuation indicator

The attenuation indicator shall have a minimum range of 70 dB and a reading accuracy of 1 dB.

B.1.3 RMS value indicator

The instrument shall accurately indicate non-sinusoidal signals in a ratio of up to 10:1 between peak value and rms value.

B.1.4 Oscillator and amplifier

The crystal oscillator and the amplifier shall be designed in such a way that the measurement of the adjacent channel power of a low-noise unmodulated transmitter, whose self-noise has a negligible influence on the measurement result, yields a measured value of < -80 dB.

Annex C (informative): Bibliography

- Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity (R&TTE Directive).

History

Document history			
V1.1.1	January 2008	Public Enquiry	PE 20080523: 2008-01-23 to 2008-05-23