



The European Organisation for Civil Aviation Equipment
L'Organisation Européenne pour l'Équipement de l'Aviation Civile

**MINIMUM OPERATIONAL PERFORMANCE SPECIFICATION
FOR AIRBORNE VHF RECEIVER - TRANSMITTER
OPERATING IN THE FREQUENCY RANGE 117.975 - 137.000 MHz**

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ED-23C

June 2009

Supersedes
ED-23B, March 1995

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FOREWORD

1. This document prepared by EUROCAE Working Group 47 and updated by EUROCAE Climax/8.33 TF was accepted by the Council of EUROCAE on 15 June 2009.
2. EUROCAE is an international non-profit making organisation in Europe. Membership is open to European users and manufacturers of equipment for aeronautics, trade associations, civil aviation administrations and, under certain conditions, non-European Members. Its work programme is directed to the study of technical problems facing users and manufacturers of equipment for aeronautics and all related questions. It aims to contribute at national and international levels to the solution of such problems.
3. This document supersedes the "Minimum Performance Specification for Airborne VHF Communication Equipment operating in the frequency range 117.975-137.000 MHz (Receiver-Transmitter)", ED-23B, March 1995.

As compared with the previous document, the main changes are :

- a. Addition of Class H1 and Class H2 receivers, which are able to be used in an 8.33 kHz multi-carrier system, as the solution for VHF frequency congestion in Europe.
- b. New requirements for Class C receivers, which are able to be used in 25 kHz multi-carrier systems

The following table is given for information. It contains revised performance limits for receivers intended to be used in 8.33 kHz and 25 kHz multi-carrier systems:

	Class C and Class H1	Class H2
Multi-Carrier Sensitivity (in 25kHz and 8.33 kHz channel spacing)	-85dBm	-90dBm
Audio Frequency Response	-18dB @ 4 kHz	-35dB @ 4 kHz
Multi-Carrier Distortion (-33dBm combined carrier level) 350Hz – 1.5kHz mod	25% @ 85% mod depth	25% @ 85% mod depth
Multi-Carrier Distortion (-33dBm combined carrier level) 1kHz mod	15% @ 30% mod depth	15% @ 30% mod depth
Audio output power reduction Single carrier / multi-carrier @ -90dBm 1kHz mod	Not Applicable	10dB

- c. ED-14C/DO-160C replaced by ED-14F/DO-160F. However the use of ED-14C/DO-160C can be acceptable for radios which have already been certified using ED-23B. (for example : radios upgraded to Class H1 or H2)
- d. Protection of the GNSS band.
- e. Transmitters Classes 1 & 2 and Receivers Classes A & B have been removed.
- f. New recommendation on Complex Electronic Hardware in §2.8.

Manufacturers should note that in the future, all or part of the frequency band 108.000 to 117.975 MHz may become available for aeronautical communications.

4. The findings of EUROCAE are resolved after discussion amongst Members of EUROCAE, and interested Administrations, in coordination with RTCA, Inc., WASHINGTON DC, USA and/or SAE/the Society of Automotive Engineers, WARRENDALE, PA, USA, through their appropriate committees.
5. Co-ordination of this document has been achieved with RTCA Special Committee SC-172 during its preparation.
6. EUROCAE Minimum Operational Performance Specifications are recommendations only ; EUROCAE is not an official body of the European Governments. Its recommendations therefore are valid as statements of official policy only when adopted by particular government or conference of governments.

CHAPTER 1

GENERAL

1.1 PURPOSE AND SCOPE

- 1.1.1 This document contains a minimum operational performance specification for airborne VHF communications equipment (receiver and transmitter) intended to be used for air-ground communication. It is designed to ensure that equipment certified to it will be compatible with the relevant ICAO Standards and Recommended Practices as described in ICAO Annex 10 Sections 4.5, 4.7 and Appendix D. It is also intended to cover equipment suitable for use in an 8.33 kHz channel separation environment.

NOTE: *In the following text the channel spacing for 8.33 kHz channel assignments is defined as 25 kHz divided by 3 which is 8.3333.... kHz.*

- 1.1.2 This minimum operational performance specification defines the minimum performance expected of an aircraft VHF receiver-transmitter equipment; the performance of a specific equipment may be enhanced or superior to this specification depending on the intended application and configuration.
- 1.1.3 [Chapter 1](#) describes typical equipment applications and operational objectives and is the basis for the performance criteria specified in Chapter 2 and Chapter 3. Definitions essential to proper understanding of this document are also provided in Chapter 1.
- 1.1.4 [Chapter 2](#) contains general design requirements.
- 1.1.5 [Chapter 3](#) contains the minimum performance specification for the equipment, defining performance under standard operating conditions.
- 1.1.6 [Chapter 4](#) prescribes the environmental test conditions which provide a laboratory means of determining the overall performance characteristics of the equipment under conditions representative of those which may be encountered in actual operations.
- 1.1.7 [Chapter 5](#) describes recommended test procedures for demonstrating compliance with Chapter 3.
- 1.1.8 [Chapter 6](#) specifies the performance of the installed equipment. Ground and flight tests for the installed equipment are included when performance cannot be adequately determined through testing under standard test conditions.

1.2 APPLICATION

- 1.2.1 Compliance with this minimum operational performance specification by manufacturers, installers and users is recommended as a means of ensuring that the equipment will satisfactorily perform its intended functions under the conditions normally encountered in routine aircraft operations.
- 1.2.2 Any regulatory application of this document in whole or in part is the sole responsibility of appropriate government agencies.
- 1.2.3 As the measured values of equipment performance characteristics may be a function of the method of measurement, standard test conditions and methods of testing are recommended in this document.

1.2.4 Mandating and Recommendation Phrases

a. "Shall"

The use of the word SHALL indicates a mandated criterion; i.e. compliance with the particular procedure or specification is mandatory and no alternative may be applied.

b. "Should"

The use of the word SHOULD (and phrases such as "IT IS RECOMMENDED THAT ...", etc.) indicate that though the procedure or criterion is regarded as the preferred option, alternative procedures, specifications or criteria may be applied, provided that the manufacturer, installer or tester can provide information or data to adequately support and justify the alternative.

1.3 DESCRIPTION OF SYSTEM

1.3.1 The air-ground VHF communication system is based on the use of continuous wave (CW) amplitude modulated carriers, and the emissions are vertically polarised.

1.3.2 Operational Frequency Range

For all classes of equipment defined in [2.6](#), the receiver-transmitter shall operate in the band 117.975 to 137 MHz. The lowest assignable channel is centred on 118.000 MHz and the highest selectable channel is centred on 136.975 MHz.

The channel labelling used is based on the following frequency-channel pairing plan which allows unique identification of the 8.33 kHz channels:

Frequency (MHz)	Channel spacing (kHz)	Channel name
118.0000	25	118.000
118.0000	8.33	118.005
118.0083	8.33	118.010
118.0166	8.33	118.015
118.0250	25	118.025
118.0250	8.33	118.030
118.0333	8.33	118.035
118.0416	8.33	118.040
118.0500	25	118.050
118.0500	8.33	118.055
118.0583	8.33	118.060
118.0666	8.33	118.065
118.0750	25	118.075
118.0750	8.33	118.080
118.0833	8.33	118.085
118.0916	8.33	118.090
118.1000	25	118.100
etc		

NOTE: The above operation frequency range limitations may not apply to all receiver transmitters and their associated control panels. For some applications the receiver transmitter may be capable of tuning 8.33 kHz channels outside of these limits.

1.4 COMPOSITION OF EQUIPMENT

VHF communications equipment carried on aircraft normally comprises a receiver-transmitter and an aerial, together with input/output equipment such as displays, controls, microphones and headphones which allow the aircrew to interface with the system. This MOPS specifies the performance of the receiver-transmitter equipment only, but includes some guidance (in [Chapter 6](#)) on the installation of the controls and displays.

1.5 DEFINITIONS

1.5.1 Depth of Modulation

The depth of modulation is the fractional ratio, expressed as a percentage, of the difference and sum of the numerical values of the largest and smallest amplitudes encountered in one cycle of modulation (See Figure 1-1),

$$\text{(i.e. Modulation Percentage)} = \frac{A - B}{A + B} \times 100$$

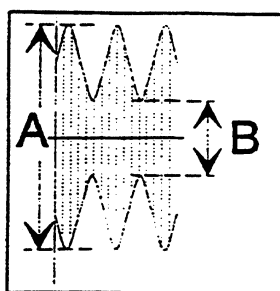


FIGURE 1-1: DEPTH OF MODULATION

1.5.2 Input Signal Levels

Unless otherwise specified, all input signal levels quoted in this document are in terms of dBm (dB referred to 1 milliwatt in 50 ohms).

1.5.3 Declared Audio Output Power

It is declared by the manufacturer to be the maximum available from the equipment within the limits of the requirements for Distortion (paragraph [3.1.5](#)).

1.5.4 Effective Bandwidth

The effective bandwidth is the receiver bandwidth available after any local oscillator and intermediate frequency drift has been taken into account. It should be noted that the actual bandwidth required to meet the effective bandwidth specification will depend on the stability of the receiver. The stability of the receiver has not been defined in paragraph [3.1.7](#) since there is a choice existing in the relationship between stability and intermediate frequency filter shape factor.

NOTE 1: An example for effective bandwidth for class C equipment, as defined in paragraph 3.1.7 (3) is shown in Figure 1-2.

NOTE 2: The effective bandwidth includes 140 Hz Doppler shift as an assumed maximum.

1.5.5 Adjacent Channel Rejection

Adjacent Channel Rejection is a measure of the ability of a receiver to suppress a modulated signal in an adjacent channel, such that a specified degradation of the signal-to-noise ratio of the desired modulated signal is not exceeded. Transmitter frequency tolerance and Doppler shift are taken into account.

1.5.6 Duty Cycle

When the equipment is not declared for Continuous Operation, the Duty Cycle shall be declared in absolute terms and not as a percentage.

1.5.7 Units of Measurement

The units used in this document are generally as defined in ICAO Annex 5 « Units of Measurement to be used in Air and Ground Operations »

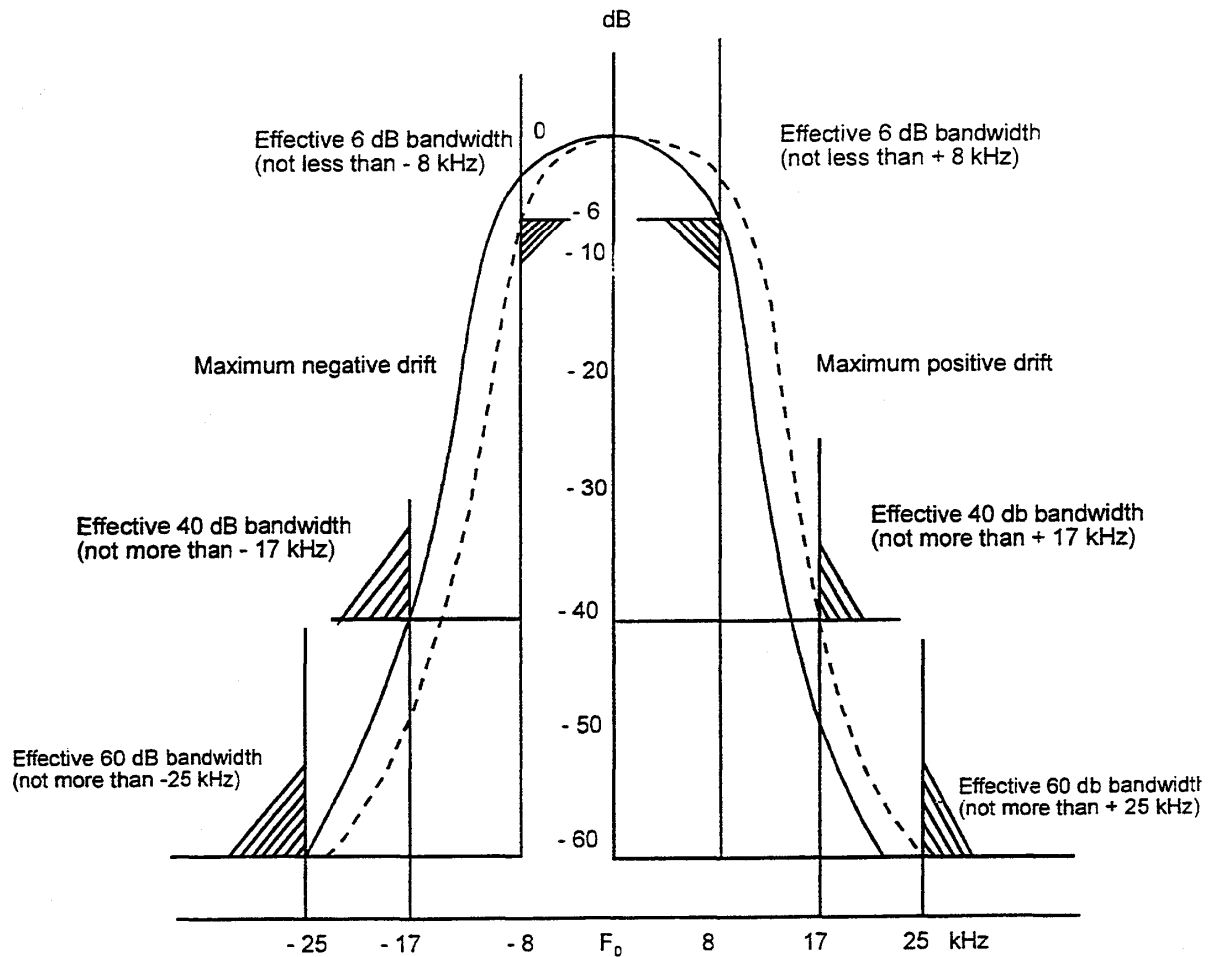


FIGURE 1-2: EFFECTIVE BANDWIDTH (1)

(1) Example for Class C Equipment

CHAPTER 2

GENERAL DESIGN REQUIREMENTS

2.1 AIRWORTHINESS

The equipment shall not, under either normal or fault conditions, impair the airworthiness of the aircraft in which it is installed.

2.2 INTERNATIONAL TELECOMMUNICATIONS UNION (ITU)

The equipment shall comply with the relevant ITU Regulations or such other requirements as are applicable.

2.3 OPERATION OF CONTROLS

The operation of controls intended for use during flight, in all possible positions, combinations and sequences, shall not result in a condition whose presence or continuation would be detrimental to the continued performance of the equipment.

NOTE: *It is strongly recommended to provide an indication or annunciation to the pilot of transmitter operation. This feature will reduce the continuing problem of inadvertent transmitter keying.*

2.4 ACCESSIBILITY OF CONTROLS

Controls which are not intended to be adjusted by the flight crew shall not be readily accessible.

2.5 EFFECTS OF TESTS

Unless otherwise provided, the design of the equipment shall be such that, subsequent to the application of the specified tests, no condition exists which would be detrimental to the continued performance of the equipment.

2.6 EQUIPMENT CLASSES

2.6.1 Receivers

Four classes of receiver are defined as follows :

Class C	Receivers which are to be used in a 25 kHz channel separation environment and intended for off-set carrier operation with two to five carriers.
Class D	Receivers which are to be used in a 25 kHz channel separation environment but NOT intended for off-set carrier operation.
Class E	Receivers which are to be used in a 8,33 kHz channel separation environment but NOT intended for off-set carrier operation.
Class H1 and H2	Receivers which are to be used in a 8,33 kHz channel separation environment and intended for off-set carrier operation with only two carriers.

NOTE 1: *Regarding receivers manufactured to comply with Class H, Manufacturers are reminded that Class H1 receivers may not be installed in the future when equippage of Class H2 receivers becomes mandatory.*

NOTE 2: *Class F receivers are defined in ED-92A (VDL2 MOPS) and Class G receivers in DO-271C (VDL3).*

NOTE 3: *As the European Region of ICAO has adopted 25 kHz channel separation and 8.33 kHz channel separation, multi class receivers (C, E, H1 and H2) are expected to be used.*

2.6.2 Transmitters

Four classes of transmitter are defined as follows :

Class 3	200 miles range for use within a 25 kHz channel separation environment.
Class 4	100 miles range for use within a 25 kHz channel separation environment.
Class 5	200 miles range for use within a 8.33 kHz channel separation environment.
Class 6	100 miles range for use within a 8.33 kHz channel separation environment.

NOTE: *As the European Region of ICAO has adopted 25 kHz channel separation and 8.33 kHz channel separation, dual class transmitters (3 and 5) are expected to be used.*

Refer to 3.2.1 for clarification.

2.7 UNINTENTIONAL CONTINUOUS TRANSMISSIONS

A means should be provided to reduce the adverse effect on safety of unintentional continuous transmissions.

If provided, it shall indicate to the crew in an efficient way that transmission has been running for 35 ± 5 seconds.

NOTE: *An acceptable means of implementation is described in EUROCAE document ED-67.*

2.8 DIGITAL COMPUTER TECHNIQUES AND COMPLEX ELECTRONIC HARDWARE

If the equipment design is implemented using digital computer techniques, the computer software package should follow guidelines contained in EUROCAE document ED-12B "Software Considerations in Airborne Systems and Equipment Certification". The RTCA equivalent document DO-178B, or later editions of both ED-12B and DO-178B, may be used with the agreement of the Approving Authority.

If the equipment design is implemented using complex electronic hardware items, the items should follow guidelines contained in EUROCAE document ED-80 "Design Assurance Guidance for Airborne Electronic Hardware". The RTCA equivalent document DO-254, or later editions of both ED-80 and DO-254, may be used with the agreement of the Approving Authority.

NOTE: *The recommendation related to complex electronic hardware is specific to new designs and not to retrofitted radios which have already been certified using earlier revisions of ED-23B. (for example: radios upgraded to Class H1 or H2)*

CHAPTER 3

MINIMUM PERFORMANCE SPECIFICATION UNDER STANDARD TEST CONDITIONS

3.1 RECEIVER

3.1.1 Audio Frequency Response

- a. The receiver audio output shall not vary by more than 6 dB when the level of an RF signal modulated 30 % is held constant at -53 dBm and the modulation frequency is varied over the audio frequency range of 350-2500 Hz.
- b. For Class C, Class D, Class E and Class H1 receivers, the audio frequency response above 2 500 Hz shall decrease and at all frequencies above 4000 Hz it shall be at least 18 dB below the output obtained at 1000 Hz.
- c. For Class H2 receivers, the audio frequency response above 2500 Hz shall decrease and at all frequencies above 4000 Hz it shall be at least 35 dB below the output obtained at 1000 Hz.

3.1.2 Automatic Gain Control

- a. The audio output power shall not vary by more than 6 dB when the level of an RF input signal, modulated 30 % at 1000 Hz, is varied from the single carrier sensitivity specified in 3.1.3.1 to -33 dBm.
- b. When the level of an RF input signal modulated 30 % at 1000 Hz, at the selected channel frequency, is suddenly reduced from -7 dBm to the single carrier sensitivity specified in 3.1.3.1, the receiver shall recover within 0.25 seconds (see NOTE).
- c. When the receiver is part of an equipment which includes a transmitter, the receiver shall recover from a transmit-to-receive transfer operation within 0.25 seconds (see NOTE).

NOTE: *Recovery is defined as the time taken for the receiver audio output level to return to and remain within 3 dB of that steady output obtained with an input signal equal to the sensitivity specified in 3.1.3.1, modulated 30 % at 1000 Hz.*

3.1.3 Sensitivity (Signal-Plus-Noise to Noise Ratio)

3.1.3.1 Single Carrier Sensitivity

The level of a single carrier RF input signal, modulated 30 % at 1000 Hz, required to produce a signal-plus-noise to noise ratio of 6 dB shall not exceed -93 dBm with an audio output power not lower than 10 dB below the declared audio output power.

3.1.3.2 Multi-Carrier Sensitivity

For Class C and H1, the combined level of a multi-carrier RF input signal, modulated 30 % at 1000 Hz, required to produce a signal-plus-noise to noise ratio of 6 dB shall not exceed -85 dBm with an audio output power not lower than 10 dB below the declared audio output power.

For Class H2, the combined level of a multi-carrier RF input signal, modulated 30 % at 1000 Hz, required to produce a signal-plus-noise to noise ratio of 6 dB shall not exceed -90 dBm with an audio output power not lower than 10 dB below the declared audio output power.

3.1.4 Output Level Control

If an output level control is provided, it shall be capable of reducing the output to at least 40 dB below manufacturer's rated output.

3.1.5 Distortion

NOTE: *The distortion requirements do include all undesired signals*

3.1.5.1 Single-Carrier Distortion

- a. The distortion in the receiver output shall not exceed 25 % at rated power output when the receiver input signal is modulated 85 % at a level of -33 dBm. This requirement shall be met over the frequency range of 350 to 2500 Hz.
- b. The distortion in the receiver output shall not exceed 15 % at a level 10 dB below rated power output when the receiver input signal is modulated 30 % at an input signal level of -33 dBm. This requirement shall be met over the frequency range of 350 to 2500 Hz.

3.1.5.2 Multi-Carrier Distortion (for Class C, H1 and H2 receivers)

- a. The distortion in the receiver output shall not exceed 25 % at rated power output when each individual receiver input signal is modulated 85 % at a level of -33 dBm. This requirement shall be met over the frequency range of 350 to 1500 Hz.
- b. The distortion in the receiver output shall not exceed 15 % at a level 10 dB below rated power output when each individual receiver input signal is modulated 30 % at an input signal level of -33 dBm. This requirement shall be met at 1000 Hz.

3.1.6 Audio Noise Level

The signal-plus-noise to noise ratio of the receiver audio output shall be at least 25 dB over the RF input signal range of -67 dBm to -33 dBm when the signal is modulated 30 % at 1000 Hz.

When the equipment is designed for operation from an alternating current supply, this requirement shall be met over the range of supply frequencies for which the equipment is declared to operate.

3.1.7 Effective Bandwidth

(1) Class C Equipment:

The effective bandwidth, relative to the selected channel frequency, shall be:

- a. not less than ± 8 kHz at the 6 dB points,
- b. not greater than ± 17 kHz at the 40 dB points,
- c. not greater than ± 25 kHz at the 60 dB points.

NOTE: *The attenuation value at paragraph 3.1.7 (1) b. is a minimum acceptable. It is recommended that every effort be made to achieve a value of 50 dB at ± 17 kHz in order to ensure interference free reception.*

(2) Class D Equipment:

The effective bandwidth, relative to the selected channel frequency, shall be :

- a. not less than ± 3 kHz at the 6 dB points,
- b. not greater than ± 22 kHz at the 60 dB points.

(3) Class E, Class H1 and Class H2 Equipment:

The effective bandwidth, relative to the selected channel frequency, shall be for 8.33 kHz channel spacing mode:

- a. not less than ± 2.78 kHz at 6dB points,
- b. not greater than ± 7.37 kHz at the 60dB points.

3.1.8 Spurious Responses

The level of an input signal on an undesired frequency required to produce a detector carrier level equal to that required for a 6 dB signal-plus-noise to noise ratio, as specified in paragraph 3.1.3.1, shall not be less than -33 dBm :

- a. When the undesired signal is within the band 108 to 137 MHz and is on any frequency within ± 8 kHz of any assignable channel, other than the desired channel and its upper and lower adjacent channels.
- b. When the undesired signal is between 50 kHz and 1 215 MHz, excluding the range 108 to 137 MHz.

This requirement shall be met on all frequency channels for which the equipment is designed.

3.1.9 Cross Modulation

The audio output power due to cross modulation resulting from the simultaneous application to the receiver input of wanted and unwanted signals, as specified below, shall be at least 10 dB below that value obtained on application of the wanted signal only, when modulated 30 % at 1 000 Hz.

Wanted signal:

Level : From -87 dBm to -59 dBm.
 Modulation : None.
 Frequency : Selected frequency.

Unwanted signal:

Level : -33 dBm.
 Modulation : 30 % at 1 000 Hz.
 Frequency : 108 to 156 MHz (including the frequencies equivalent to the second higher and second lower channels to which the receiver can be tuned but excluding the frequency range between these two channels).

NOTE: *If an audio compressor is included in the equipment, it may be disabled when conducting this test.*

3.1.10 Intermodulation

With the receiver audio compressor disabled (if so equipped) and with the squelch also disabled (if equipped) the simultaneous application of two unmodulated undesired signals, within the frequency range of 87.5 to 107.9 MHz, with levels at the receiver input terminals of -5 dBm, shall result in an audio quieting of less than 6 dB.

NOTE: *Audio quieting is defined as the reduction in audio output level below that audio output level obtained with no RF signal applied to the receiver.*

3.1.11 Desensitisation

The signal-plus-noise to noise ratio of the receiver shall not decrease to less than 6 dB when the specified unwanted signals are applied in addition to the wanted signal.

Wanted signal:

Level : -87 dBm.
 Modulation : 30 % at 1 000 Hz.
 Frequency : Selected frequency.

Unwanted signal A:

Level : -33 dBm.
 Modulation : None.
 Frequency range : 108 to 156 MHz (including the frequencies equivalent to the next higher and the next lower channels to which the receiver can be tuned but excluding the frequency range between these two channels).

Unwanted signal B:

Level : - 7 dBm

NOTE: *The level may be reduced to -33 dBm at discrete spurious response frequencies.*

Modulation : None.
 Frequency range : 50 kHz to 1 215 MHz (excluding the range 87.5 to 156 MHz).

Unwanted signal C:

Level : -5 dBm.
 Modulation : None.
 Frequency range : 87.5 to 107.9 MHz.

3.1.12 Spurious Emissions

- a. When the receiver input is terminated in a resistive load equal to the nominal receiver input impedance, the level of any spurious emission appearing across the load shall not exceed -57 dBm over the frequency range of 50 kHz to 1215 MHz, with the exception of the range of 108 to 137 MHz, where it shall not exceed -64 dBm.
- b. The levels of conducted and radiated spurious radio frequency energy emitted by the equipment shall not exceed those levels specified in documents ED-14F/DO-160F, Section 21. The use of later editions of these documents must be agreed with the appropriate approval authority. The use of ED-14C/DO-160C or later versions of these documents can be acceptable for radios which have already been certified using ED-23B. (for example : radios upgraded to Class H1 or H2)

3.1.13 Channel Selection Time

When a channel is selected, the time required for the equipment audio output to reach and remain within 3 dB of the steady state output shall not exceed one second.

3.1.14 Audio output power in Multi-carrier systems (Class H2 receivers only)

The audio output power when receiving two carriers at -93 dBm (-90 dBm total power) shall not be more than 10 dB below the audio power recorded when receiving a single carrier at -90 dBm.

3.1.15 Adjacent Channel Rejections (Class E, Class H1 and H2)

With the desired and interfering signals as specified below, the Adjacent Channel Rejection (ratio between desired signal level and the lowest interfering signal level, in dB) shall be at least 45 dB.

It is worth noting that the receiver local oscillator phase noise should be sufficiently low to avoid any degradation of the receiver capability to reject off channel signals. For Class E equipment, a phase noise level better than -99 dBc/Hz, 8.33 kHz away from the carrier, is necessary to comply with a 45 dB Adjacent Channel Rejection.

Desired signal:

Level : adjusted to produce a S+N/N ratio of 20 dB

Modulation : modulated 60% at 1 000 Hz

Frequency : selected frequency

Interfering signal:

Level : adjusted so that the S+N/N ratio of the desired signal is degraded from 20 dB to 14 dB.

Modulation : modulated 60% at 400 Hz

Frequency : first upper and lower adjacent channel

3.2 TRANSMITTER

3.2.1 Power Output

The transmitter output modulated and unmodulated, on all frequency channels for which the equipment is designed, shall not be less than the manufacturer's declared value.

NOTE 1: *The following table indicates the minimum modulated output power which will normally be necessary for given radio-line-of-sight distances. In the determination of the required output power, it has been assumed that a properly installed and matched antenna system is used.*

Classes	Distance (Nautical Miles)	Minimum Output Power (Watts)
3 & 5	200	16
4 & 6	100	4

NOTE 2 : *It is recommended that the output power be limited to 25 watts to minimise interference.*

3.2.2 Residual Radiation

When all sources of primary power are connected to the transmitter and the microphone switch is in the "OPEN" position, the RF power output of the transmitter at the selected frequency shall not exceed -107 dBm.

3.2.3 Modulation Capability

The transmitter output carrier shall be amplitude modulated not less than 70 % by an audio-frequency input signal of 1 000 Hz over the audio input voltage range for which the transmitter is designed. Means should be provided to maintain the average modulation factor at the highest practicable value without creating over-modulation.

3.2.4 Audio Frequency Distortion

The combined distortion and noise in the modulated output of the transmitter shall not be greater than 25 % of the total demodulated output.

This requirement shall be met when the audio input signal is held constant at a level just below that at which, at the frequency of maximum response, clipping or limiting action occurs.

NOTE: *For Class 5 and Class 6 equipment, the distortion shall be consistent with the required transmitter occupied spectrum (see para [3.2.7](#)).*

3.2.5 Audio Frequency Response

3.2.5.1 Modulation fidelity

The output carrier percentage modulation shall not vary more than 6 dB when the frequency of the audio input signal is varied over the range of 350 to 2 500 Hz when the level of the audio input signal is held constant at that value which produces :

- a. 70 % modulation at the frequency of maximum response or
- b. more than 70 % modulation at the frequency of maximum response when this value is immediately below that at which clipping or limiting action occurs.

For Class 5 and Class 6 equipment, a cut-off in response above 2 500 Hz is required, and frequencies above 3 200 Hz shall be attenuated as specified in paragraph 3.2.7.2

3.2.5.2 Sidetone

The transmitter shall provide audio frequency sidetone varying by not more than 10 dB with the frequency response and conditions as above and of a level sufficient to operate at least one headset of standard sensitivity (as defined in ED-18 Audio Systems Characteristics).

NOTE: *It is recommended that sidetone be so derived that a check of the operation of the associated receiver, as well as the RF circuitry of the transmitter, is provided.*

3.2.6 Carrier Noise Level

The de-modulated noise output obtained from the unmodulated RF carrier shall be at least 35 dB below the demodulated output obtained from the RF carrier when this is modulated to a depth of 70 % by a 1 000 Hz audio input signal.

When the equipment is designed for operation from an alternating current power source, this requirement shall be met over the range of power source frequencies for which the equipment is designed.

3.2.7 Emission of Radio Frequency Energy

3.2.7.1 Emission of Spurious and Harmonic Radio Frequency Energy

- a. The levels of conducted and radiated spurious radio frequency energy emitted by the equipment shall not exceed those levels specified in ED-14F/DO-160F, Section 21, for the aircraft category for which the equipment is designed. The use of later editions of this document must be agreed with the appropriate approval authority. The use of ED-14C/DO-160C or later versions of these documents can be acceptable for radios which have already been certified using ED-23B. (for example : radios upgraded to Class H1 or H2)

- b. When the transmitter is modulated 30 % at 1 000 Hz and is terminated in a resistive load equal to the nominal output impedance, the power of any spurious emission at the output of the transmitter shall not exceed :
- -26 dBm at frequencies within the range 108 to 112 MHz.
 - -16 dBm or a level 40 dB below the power at the selected frequency, whichever is the most stringent, at frequencies within the range 50 kHz to 1 215 MHz (excluding frequencies within the range 108 to 112 MHz and those within plus and minus 25 kHz of the selected frequency, and ± 8.33 kHz of the selected frequency for Class E equipment in 8.33 kHz environment) ; however the power of the emission need not be reduced below -20 dBm.
- c. Harmonic emission products shall be at least 60 dB below the rated RF output power, i.e., minus 60 dBc. Harmonic emission products in the ICAO Global Navigation Satellite System (GNSS) band extending from 1559 to 1610 MHz shall be no greater than minus 60 dBm.

NOTES:

1. *Spurious emissions are power emissions that are outside the desired bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include parasitic emissions, intermodulation products and frequency conversion products.*
2. *In order to ensure adequate protection of a GNSS receiver when a transceiver is operated on the same aircraft, the manufacturers should ensure that the transmitter harmonic filter remains effective at frequencies in the band 1559 – 1610 MHz.*
3. *If other receiving systems are installed, transmitter harmonics may interfere with those systems.*

3.2.7.2 Transmitter Occupied Spectrum for 8.33 kHz Mode

For 8.33 kHz mode (Class 5 and Class 6 equipment), the transmitter spectrum shall not exceed the limits shown in [Figure 3-1](#) when the transmitter is modulated by any frequency between 300 Hz and 10 kHz, the input level being adjusted as follows:

- The level of the audio signal is adjusted to produce 70 % modulation at 1 000 Hz.
- Then the frequency of the audio signal is varied in the range 300 Hz - 10 kHz, at the constant above mentioned level between 300 and 800 Hz, and following a slope of -10 dB/octave, between 800 Hz and 10 kHz.