



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

**MINIMUM OPERATIONAL PERFORMANCE SPECIFICATION FOR
MULTI-MODE AIRBORNE RECEIVER (MMR) INCLUDING ILS, MLS, AND GPS
USED FOR SUPPLEMENTAL MEANS OF NAVIGATION**

This document is the exclusive intellectual and commercial property of EUROCAE.

It is presently commercialised by EUROCAE.

This electronic copy is delivered to your company/organisation for internal use exclusively.

In no case it may be re-sold, or hired, lent or exchanged outside your company.

ED-88

August 1997

**MINIMUM OPERATIONAL PERFORMANCE SPECIFICATION FOR
MULTI-MODE AIRBORNE RECEIVER (MMR) INCLUDING ILS, MLS, AND GPS
USED FOR SUPPLEMENTAL MEANS OF NAVIGATION**

This document is the exclusive intellectual and commercial property of EUROCAE.

It is presently commercialised by EUROCAE.

This electronic copy is delivered to your company/organisation for internal use exclusively.

In no case it may be re-sold, or hired, lent or exchanged outside your company.

ED-88

August 1997

TABLE OF CONTENTS

	<u>Page</u>
FOREWORD	ii
CHAPTER 1 INTRODUCTION	1
1.1 Purpose and scope	1
1.2 Operational Applications	3
1.3 System Description	3
1.4 Abbreviations	4
1.5 Airborne System Controls and Outputs	4
CHAPTER 2 GENERAL DESIGN SPECIFICATIONS	6
2.1 Airworthiness.....	6
2.2 International Telecommunications Union (ITU)	6
2.3 Fire Protection.....	6
2.4 Operation of Controls.....	6
2.5 Effects of Tests	6
2.6 Software Design.....	6
2.7 Intended Function	6
2.8 Airborne System Integrity and Continuity of Service	7
2.9 Displays.....	7
2.10 Equipment Performance	7
2.11 Rating of Components	7
CHAPTER 3 MINIMUM PERFORMANCE SPECIFICATION UNDER STANDARD TEST CONDITIONS	8
3.1 Functional Requirements	8
3.2 ILS Localiser/GPS Minimum Performance Specification.....	8
3.3 ILS Glide Path/GPS Minimum Performance Specification	8
3.4 MLS/GPS Minimum Performance Specification	8
3.5 Cross Coupling Performance Specification	9
3.6 Mode Swithching.....	11
CHAPTER 4 MINIMUM PERFORMANCE SPECIFICATION UNDER ENVIRONMENTAL TEST CONDITIONS	12
4.1 ILS Localiser and GPS Minimum Performance Specifications	12
4.2 ILS Glide Path and GPS Minimum Performance Specifications.....	12
4.3 MLS and GPS Minimum Performance Specifications	12
CHAPTER 5 ELECTRICAL TEST PROCEDURES	13
5.1 Introduction	13
5.2 ILS, MLS and GPS Functions Performance Tests	13
5.3 Mode Independence Tests with ILS Mode Selected.....	14
5.4 Mode Independence Tests with MLS Mode Selected.....	15
5.5 Mode Independence Tests when GPS is in Operation	15
5.6 Cross Coupling Performance Tests.....	16
Figure 5-1 Example of MMR Out Of Band Signal Rejection Test Bench	17
LIST OF EUROCAE WORKING GROUP 43 MEMBERS	18

FOREWORD

1. This document, prepared by EUROCAE Working Group 43 was accepted by the Council of EUROCAE in August 1997.
2. EUROCAE is an international non-profit making organisation. Membership is open to European users and manufacturers of equipment for aeronautics, trade associations, national civil aviation administrations and, under certain conditions, non-European members. Its work programme is principally directed to the preparation of performance specifications and guidance documents for civil aviation equipment, for adoption and use at European and world-wide levels
3. The findings of EUROCAE are resolved after discussion amongst its members and in co-operation with RTCA Inc., Washington D.C., U.S.A., and/or the Society of Automotive Engineers (SAE), Warrendale PA, USA through their appropriate committees.
4. This document is the first version of a MOPS for a Multi-Mode receiver including ILS, MLS and GPS airborne receiving equipment used for supplemental means of navigation. This MOPS makes references and is compliant with ED-36A (MOPS for MLS Airborne Receiving Equipment Feb 95) , ED-46B (MOPS for Airborne ILS Localiser Receiving Equipment Sept 95), ED-47B (MOPS for Airborne ILS Glide Path Receiving Equipment Sept 95) and ED-72 A (MOPS for Airborne GPS Receiving Equipment used for supplemental means of navigation April 97).
5. Co-operation has been achieved with EUROCAE WG-28 GNSS.
6. EUROCAE performance specifications are recommendations only. EUROCAE is not an official body of the European Governments; its recommendations are valid as statements of official policy only when adopted by a particular government or conference of governments.
7. Copy of this document may be obtained from

EUROCAE
17 rue Hamelin
75783 PARIS CEDEX 16
FRANCE

CHAPTER 1

INTRODUCTION1.1 PURPOSE AND SCOPE

The Minimum Operational Performance Specification is designed to ensure that airborne receiving equipment approved as complying with it, will be compatible with the ICAO Standards and Recommended Practices in respect of Microwave Landing System (MLS) and Instrument Landing System (ILS) localiser and glide path functions.

This Minimum Operational Performance Specification is also designed to ensure that any incorporated airborne GPS receiving equipment will be compatible with the technical specification for GPS as defined in the document "GPS Standard Positioning Service - Signal Specifications" and in "Technical characteristics of the Navstar GPS", obtainable from SMC/PA 2430, El Segundo Blvd, Suite 4049, LOS ANGELES AFB, CA90245-4687, USA.

This Minimum Operational Performance Specification specifies the particular operational performance requirements applicable to airborne receiving systems with ILS, MLS and GPS functions incorporated within a single equipment. The requirements of this document shall be met by a combined ILS/MLS/GPS receiver when operating in either one of two mutually exclusive modes (ILS/MLS) in addition to the GPS, if included.

A receiver meeting the requirements of this document shall be capable of operating in either ILS or MLS mode and at the same time performing GPS position determination, if GPS is included.

In addition to meeting the requirements of this document, a combined ILS/MLS/GPS receiver shall fully meet the minimum operational performance requirements of EUROCAE ILS, MLS and GPS MOPS when operating in the appropriate mode. Several specific requirements of ED-46B/ED-47B (ILS), ED-36A (MLS) and ED-72A (GPS) are referenced in this document.

The inclusion of ILS, MLS or GPS functions in the receiver is optional. If any function is not present, all the appropriate paragraphs in this document referring to that function may be disregarded.

Mandatory clauses are noted by "shall".

Environmental test requirements have been specified in respect of the parameters which may be particularly susceptible to the effects of environment. Although this document provides a single minimum performance standard for receivers, several alternative environmental categories, as specified in EUROCAE ED-14C/RTCA DO-160C may exist. Those categories applicable to the conditions over which the equipment is declared to operate shall be applicable.

Demonstration of compliance with certain of the requirements of this specification may involve somewhat complex test procedures, e.g. where a scalloping of input signal is required or where performance in the presence of interfering signals is to be demonstrated. Suitable test procedures in respect of these requirements are

contained in the appropriate EUROCAE MOPS and are referenced in Chapter 5. Alternative procedures providing equivalent integrity may be used.

This document provides minimum performance specifications for the airborne portion of the MLS, ILS and GPS. Should the MLS, ILS and GPS functions be incorporated into multifunction equipment with additional navigation functions, the requirements of this specification must be met when operating as an MLS or ILS and GPS receiver. The appropriate EUROCAE MOPS shall be used to define the operational performance of the additional function(s) to be incorporated.

This minimum specification does not require the provision of guidance information decoded from the MLS back azimuth ground system. The receiver must be capable of providing all guidance and data information as specified in this document whether or not MLS back azimuth is provided in the ground installation.

Guidance contained in the following documents should be considered in conjunction with this specification:

ICAO Annex 10 Part I Volume 1 : Aeronautical Telecommunications

EUROCAE ED-12B/RTCA DO-178B - Software Considerations in Airborne Systems and Equipment Certification

EUROCAE ED-14C/RTCA DO-160C - Environmental Conditions and Test Procedures for Airborne Equipment

EUROCAE ED-36A - Minimum Operational Performance Specification for Microwave Landing System (MLS) Airborne Receiving Equipment

EUROCAE ED-46B - Minimum Operational Performance Specification for Airborne ILS Localiser Receiving Equipment

EUROCAE ED-47B - Minimum Operational Performance Specification for Airborne ILS Glide path Receiving Equipment

EUROCAE ED-53A - Minimum Operational Performance Specification for Microwave Landing System (MLS) Ground Equipment

EUROCAE ED-54 - Minimum Operational Performance Requirements for Distance Measuring Equipment Interrogators (DME/N and DME/P) operating within the radio frequency range 960 - 1215 MHz airborne equipment.

EUROCAE ED-72A - Minimum Operational Performance Requirements for Airborne GPS Receiving equipment used for supplemental means of navigation

RTCA DO-177 - Minimum Operational Performance Standard for Microwave Landing System (MLS) Airborne Receiving Equipment (including Changes 1 and 2)

RTCA DO-189 - Minimum Operational Performance Standard for Airborne Distance Measuring Equipment (DME)

RTCA DO-208A - Minimum Operational Performance Standard for Airborne GPS Receiver

1.2 OPERATIONAL APPLICATIONS

The combined ILS/MLS/GPS receiver is intended for use in aircraft requiring precision approach guidance to runways equipped with ILS and/or MLS ground systems, in addition to providing GPS navigation information.

When operating in ILS mode, the receiver provides guidance to a fixed approach path defined by ILS localiser and glide path signals (normally on the extended runway centreline and 3° glideslope).

When operating in MLS mode, the receiver shall provide ILS look-alike guidance to a fixed approach path defined by azimuth and elevation angles which may, as an option, be manually selected.

NOTE: ILS look alike means a system which has outputs indicating the magnitude and sense of deviation from a preset azimuth and elevation angle giving equivalent operational characteristics to that for conventional ILS.

With range information from an appropriate DME, airborne MLS RNAV systems will support complex approach and departure procedures including automatic landing and roll-out guidance. A full description of MLS operational applications is given in EUROCAE ED-36A paragraph 1.2.

1.3 SYSTEM DESCRIPTION

ILS and MLS provide suitably equipped aircraft with precision approach guidance during final approach and landing. Characteristics of ILS and MLS are specified by ICAO Annex 10 Standards and Recommended Practices. A full technical description of MLS including the use of DME is given in EUROCAE ED-36A paragraph 1.3.

GPS provides suitably equipped aircraft with position information during all phases of flight. Characteristics of GPS system and operational use of GPS are fully described in EUROCAE ED-72A Chapter 1.

The Airborne Receiving Equipment, hereafter referred to as 'the receiver', is defined as the combination of the following elements:

- a. radio frequency (RF) sub-systems permitting the reception of signals transmitted by ILS localiser, glide path and MLS ground systems complying with ICAO Annex 10 Standards and Recommended Practices.
- b. a converter unit to decode and process the information contained in the received ILS localiser, glide path or MLS signals and generate appropriate guidance and warning signals,
- c. a radio frequency (RF) sub-system permitting the reception of GPS signals transmitted by GPS satellites as described in ED-72A Chapter 1 and a converter unit to decode and process the information contained in the received GPS signals and generate appropriate guidance and warning signals.

1.4 ABBREVIATIONS

AGC	Automatic Gain Control
AWOP	All Weather Operations Panel
DDM	Difference in Depth of Modulation
GPS	Global Positioning System
ICAO	International Civil Aviation Organization
ILS	Instrument Landing System
ITU	International Telecommunications Union
MLS	Microwave Landing System
MMR	Multi Mode Receiver
MOPS	Minimum Operational Performance Specification
MTBF	Mean Time Between Failures
RF	Radio Frequency
RNAV	Area Navigation
SARPS	Standards And Recommended Practices

1.5 AIRBORNE SYSTEM CONTROLS AND OUTPUTS

For the ILS and MLS functions, the receiver shall provide guidance, status information and facility identification. For the GPS function, the output shall be in compliance with ED-72A. Requirements for the controls and outputs which may be common to both ILS and MLS functions are given below.

1.5.1 Mode Selection

A means of Mode selection shall be provided to enable the selection of either ILS or MLS receiver functions. The selection of ILS or MLS functions shall be mutually exclusive. When ILS is selected, all MLS functions shall be disabled. When MLS is selected, all ILS functions shall be disabled. The ILS/MLS selection shall not have any impact on the GPS receiver performance.

1.5.2 RF Channel Selection

A single RF channel/frequency control common to both ILS and MLS functions may be employed. An indication of the selected channel shall be available.

1.5.3 Mode Indication

A mode indicator shall be provided to clearly display the landing selected operating mode.

1.5.4 Outputs

When the ILS function is selected, output shall be provided in the form of localiser and glide path deviations from zero DDM. When the MLS function is selected, outputs shall be provided in the form of deviations from the selected MLS azimuth and elevation angles. Common outputs may be employed for both ILS localiser and MLS azimuth functions and for both ILS glide path and MLS elevation functions. For ILS and MLS modes of operation, the MMR shall provide ILS look-alike deviation outputs.

The GPS outputs shall be independant from ILS or MLS guidance outputs. They shall be in compliance with ED-72A requirements.

1.5.5 Facility Identification

ILS localiser facility identification shall be provided as an audio output in accordance with ED-46B. MLS facility identification shall be provided in accordance with ED-36A paragraph 3.11.6.

1.5.6 Warning Outputs

When in ILS mode, the receiver shall provide warnings in accordance with ED-46B paragraph 3.13 and ED-47B paragraph 3.13. When in MLS mode, the receiver shall provide warnings in accordance with ED-36A paragraph 3.8. Generation of an MLS azimuth warning shall result in the generation of an MLS elevation warning. Common warning outputs may be employed for both ILS localiser and MLS azimuth functions and for both ILS glide path and MLS elevation functions.

The GPS warning outputs shall be independant from ILS or MLS warnings outputs. The GPS warnings outputs shall be in compliance with ED-72A requirements.

CHAPTER 2

GENERAL DESIGN SPECIFICATIONS2.1 AIRWORTHINESS

Neither the design and manufacture of the equipment nor its installation shall impair the airworthiness of the aircraft or present a hazard to personnel.

2.2 INTERNATIONAL TELECOMMUNICATIONS UNION (ITU)

All equipment shall comply with the applicable rules of the ITU and of such other authorities as may be appropriate.

2.3 FIRE PROTECTION

All materials used shall be self extinguishing except for small parts (such as knobs, fasteners, seals, grommets and small electrical parts) that would not contribute significantly to the propagation of a fire.

2.4 OPERATION OF CONTROLS

No possible position, combination or sequence of operation of any control intended for use during flight shall be detrimental to the continued performance of the equipment or the aircraft. Controls which are not normally adjusted in flight shall not be readily accessible to flight personnel.

2.5 EFFECTS OF TESTS

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

2.6 SOFTWARE DESIGN

Software design shall follow the guidelines specified in document EUROCAE ED-12B/RTCA DO-178B "Software Considerations in Airborne Systems and Equipment Certification" (Dec. 92). The software criticality level will depend on the particular equipment function and application.

2.7 INTENDED FUNCTION

All equipment shall perform its intended function(s) as defined by the manufacturer, and its proper use shall not create a hazard to other airspace users.

2.8 AIRBORNE SYSTEM INTEGRITY AND CONTINUITY OF SERVICE

For the landing functions (ILS or MLS), the integrity of the airborne receiver system shall be compatible with the global risk factor of 1×10^{-7} in any one landing as stated in Annex 10 Attachment C paragraph 2.8.1.2. This paragraph does not mandate a specific minimum level of integrity for the MMR receiver.

***NOTE:** For operations in which the guidance information is to be used throughout the last 30 seconds of the final approach to landing, a probability of undetected failure of 1×10^{-9} will normally be required by certifying Authorities for the total airborne receiving system. This may be achieved by the use of system monitors or multiple systems with intersystem comparators. Receiver designers are advised that in order to meet the system continuity of service requirements an MTBF of the order of 4 000 hours will normally be required.*

For the GPS function, the integrity of the airborne receiver system shall be in compliance with ED-72A (Chapter 3 paragraph 3.2.1)

2.9 DISPLAYS

All indications (e.g. warnings, mode operation, etc.) shall be unambiguous and clearly discernible.

2.10 EQUIPMENT PERFORMANCE

Certain performance requirements (see Chapter 3) shall be demonstrated under environmental conditions as specified in Chapter 4. The equipment, however, shall be designed to meet the performance requirements of Chapter 3 under all environmental categories declared by the manufacturer.

2.11 RATING OF COMPONENTS

Equipment components shall not exceed the ratings established by their manufacturers when the equipment is operated throughout its declared environmental range.

CHAPTER 3

MINIMUM PERFORMANCE SPECIFICATION
UNDER STANDARD TEST CONDITIONS3.1 FUNCTIONAL REQUIREMENTS

The receiver shall operate in either of the following modes and satisfy the EUROCAE MOPS relevant to the function selected :

- a. ILS mode (as specified in ED-46B and ED-47B)
- b. MLS mode (as specified in ED-36A)

The ED-72A EUROCAE MOPS shall be used to define the operational performance of the GPS function.

3.2 ILS LOCALISER/GPS MINIMUM PERFORMANCE SPECIFICATION

3.2.1 With the receiver in ILS mode and without ILS glide path, MLS and GPS signals present at the appropriate receiver inputs, the receiver shall perform in accordance with ED-46B Chapter 3 for the ILS function.

3.2.2 With the receiver in ILS mode and with ILS glide path, MLS and GPS signals present at the appropriate receiver inputs, the receiver shall perform in accordance with ED-46B Chapter 3 for the ILS function and with ED-72A Chapter 3 for the GPS function.

3.3 ILS GLIDE PATH/GPS MINIMUM PERFORMANCE SPECIFICATION

3.3.1 With the receiver in ILS mode and without ILS localiser, MLS and GPS signals present at the appropriate receiver inputs, the receiver shall perform in accordance with ED-47B Chapter 3 for the ILS function.

3.3.2 With the receiver in ILS mode and with ILS localiser, MLS and GPS signals present at the appropriate receiver inputs, the receiver shall perform in accordance with ED-47B Chapter 3 for the ILS function and with ED-72A Chapter 3 for the GPS function.

3.4 MLS/GPS MINIMUM PERFORMANCE SPECIFICATION

3.4.1 With the receiver in MLS mode and without ILS localiser, glide path and GPS signals present at the appropriate receiver inputs, the receiver shall perform in accordance with ED-36A Chapter 3 for the MLS function.

- 3.4.2 With the receiver in MLS mode and with ILS localiser, glide path and GPS signals present at the appropriate receiver inputs, the receiver shall perform in accordance with ED-36A Chapter 3 for the MLS function and with ED-72A Chapter 3 for the GPS function.

3.5 CROSS COUPLING PERFORMANCE SPECIFICATION

Additional requirements are specified for the MMR in addition to those already present in each of the individual MOPS to limit the effects of cross coupling between all RF inputs on the MMR performance in each mode.

3.5.1 ILS Localiser Spurious Responses

3.5.1.1 Localiser RF Input Requirement

The MMR shall meet the requirements of ED-46B paragraphs 3.15 and 3.16.

3.5.1.2 Glide path RF Input Requirement

The MMR Localiser reference AGC level, for a RF -86 dBm carrier input, shall not be exceeded when an undesired signal is applied to the glide path signal input in accordance with the ED-47B spurious response requirement. ED-47B para 3.14 refers.

3.5.1.3 MLS RF Input Requirement

The MMR Localiser reference AGC level shall not be exceeded when an undesired signal is applied to the MLS signal input(s) in accordance with the spurious response requirement for ED-36A. ED-36A para 3.2.4 refers.

3.5.1.4 GPS RF Signal Input

The MMR Localiser reference AGC level shall not be exceeded when an undesired signal is applied to the GPS signal input in accordance with the spurious response requirement for ED-72A. ED-72A para 3.1.2 refers.

3.5.2 ILS Glide path Spurious Responses

3.5.2.1 Glide path RF Input Requirement

The MMR glide path reference AGC level, for a RF -76 dBm carrier input, shall not be exceeded when an undesired signal is applied to the Glide path signal input in accordance with the ED-47B spurious response requirement. ED-47B para 3.14 refers.

3.5.2.2 Localiser RF Input Requirement

The MMR glide path reference AGC level shall not be exceeded when an undesired signal is applied to the localiser signal input in accordance with the ED-46B spurious response requirement. ED-46B para 3.15 and 3.16 refers.

3.5.2.3 MLS RF Input Requirement

The MMR glide path reference AGC level shall not be exceeded when an undesired signal is applied to the MLS signal input(s) in accordance with the spurious response requirement for ED-36A. ED-36A para 3.2.4 refers.

3.5.2.4 GPS RF Signal Input

The MMR glide path reference AGC level shall not be exceeded when an undesired signal is applied to the GPS signal input in accordance with the spurious response requirement for ED-72A. ED-72A para 3.1.2 refers.

3.5.3 MLS - Rejection of Out of Band Signals

3.5.3.1 MLS RF Input Requirements

The MMR shall meet the requirements of ED- 36A para 3.2.4.

3.5.3.2 Localiser RF Input Requirements

The MMR shall meet the performance requirements of ED-36A para 3.2.4 when an undesired signal is applied to the localiser signal input in accordance with the ED-46 B spurious response requirement. ED-46B para 3.15 and 3.16 refers.

3.5.3.3 Glide path RF Input Requirements

The MMR shall meet the performance requirements of ED-36A para 3.2.4 when an undesired signal is applied to the glide path signal input in accordance with the ED-47B spurious response requirement. ED-47B para 3.14 refers.

3.5.3.4 GPS RF Signal Input

The MMR shall meet the performance requirements of ED-36A para 3.2.4 when an undesired signal is applied to the GPS signal input in accordance with the spurious response requirement for ED-72A. ED-72A para 3.1.2 refers.