

ED-260A

MINIMUM AVIATION SYSTEM PERFORMANCE STANDARD (MASPS) FOR COEXISTENCE OF WIRELESS AVIONICS INTRA-COMMUNICATION SYSTEMS WITHIN 4200-4400 MHZ

LEGAL NOTICE

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, hired, lent or exchanged outside your company. It may not be reproduced, in whole or in parts, without prior written permission by EUROCAE.

07/2022
SUPERSEDES ED-260

FOREWORD

1. This document was prepared jointly by EUROCAE Working Group 96 “Wireless On-Board Avionics Networks” and RTCA SC-236 “Standards for Wireless Avionics Intra-Communication System (WAIC) within 4200-4400 MHz”, and was approved by the Council of EUROCAE on 19 July 2022.
2. EUROCAE is an international non-profit making organisation in Europe. Membership is open to manufacturers and users of equipment for aeronautics, trade associations, national civil aviation administrations, and, under certain conditions, non-European organisations. 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 Members of EUROCAE and in collaboration with RTCA Inc, Washington D.C., and/or the Society of Automotive Engineers (SAE), Warrendale PA, U.S.A., through their appropriate committees.
4. This document supersedes ED-260 Minimum Aviation System Performance Standard (MASPS) for Coexistence of Wireless Avionics Intra-Communication Systems within 4200-4400 MHz (2019). The MASPS is intended to support the ICAO SARPs for WAIC. Additional requirements in the SARPs have been identified since the initial publication of the MASPS. The technical means of compliance for the new requirements are included in this revision of the MASPS.
5. This document is technically identical to RTCA DO-378A. Coordination has been achieved with RTCA SC-236 “Standards for Wireless Avionics Intra-Communication System (WAIC) within 4200-4400 MHz”
6. EUROCAE performance specifications and other documents 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. Copies of this document may be obtained from:

EUROCAE
9 – 23 rue Paul Lafargue
93200 Saint-Denis
France

Telephone: +33 1 49 46 19 65
Email: eurocae@eurocae.net
Website: www.eurocae.net

EXECUTIVE SUMMARY

EUROCAE and RTCA have defined this Minimum Aviation System Performance Standard (MASPS) that applies to Wireless Avionics Intra-Communications (WAIC) systems utilizing the frequency band 4 200 - 4 400 MHz as allocated by the World Radiocommunication Conference (WRC) in 2015. Key criteria for allocation of the band by the WRC were (i) coexistence between WAIC systems and (ii) coexistence between WAIC systems and Radio Altimeters (RA), both on board neighboring aircraft.

This MASPS defines two Performance Requirements (PR) that ensure WAIC systems meet the above coexistence criteria. The first PR specifies the power spectral flux density allowed to be emitted by WAIC systems on board an aircraft. The second PR specifies tolerance of WAIC systems to Radio Frequency (RF) emissions from RA and WAIC systems from neighboring aircraft. Both PRs were developed consistent with ITU-R documentation and validated by significant work by the Aerospace Vehicle Systems Institute (AVSI), EUROCAE and RTCA organizations to understand and characterize the worst-case conditions that may be experienced during the normal course of operation of the worldwide aircraft fleet.

This MASPS then specifies metrics to verify the power flux density and interference susceptibility of WAIC systems.

Finally, this MASPS provides an acceptable means to demonstrate compliance along with corresponding pass/fail criteria.

TABLE OF CONTENTS

1	PURPOSE AND SCOPE.....	1
1.1	Introduction and Purpose of Document.....	1
1.2	Scope of the Document	2
1.3	Structure of the Document.....	3
1.4	Relationship to ICAO Documents	3
1.5	Airworthiness Security as it applies to WAIC.....	3
1.6	References.....	4
1.7	Acronyms.....	4
2	APPROACH AND METHODOLOGY	6
2.1	Document Development Process.....	6
2.2	Methodology (Reserved)	6
2.2.1	Operational Services and Environment Definition (OSED) (Reserved)	6
2.2.2	System Performance Requirements	6
2.3	Key Terms.....	8
2.3.1	Use of Requirements and Recommendations and Key Words.....	8
2.3.2	Assumptions.....	8
2.3.3	Requirements.....	8
2.3.4	Recommendations.....	9
3	SYSTEM PERFORMANCE REQUIREMENTS.....	10
3.1	Introduction	10
3.1.1	OPA Process (Reserved)	10
3.1.2	CRM Process/Comparative Analysis Process (Reserved).....	10
3.2	Definition of Terms	10
3.3	Assumptions.....	10
3.3.1	Operational Requirements (Reserved).....	10
3.4	System, Subsystem, and Function Performance—Standard Operational Conditions	11
3.4.1	System Requirements	11
3.4.1.1	General System Requirements	11
3.4.1.2	System Performance—Standard Operational Conditions	11
3.4.2	Subsystem/Function Performance Requirements (Reserved)	11
3.4.2.1	General Subsystem Requirements (Reserved)	11
3.4.2.2	Subsystem/Function Requirements—Standard Operational Conditions (Reserved).....	11
4	INTEROPERABILITY REQUIREMENTS (RESERVED)	12
5	PERFORMANCE VERIFICATION.....	13
5.1	Verification of Power Spectral Flux Density and Total Power Flux Density of WAIC systems.....	13
5.1.1	Acceptable Means for Performance Verification.....	13

5.1.2	Pass/Fail Criterion	16
5.2	Interference Susceptibility Verification for WAIC systems	17
5.2.1	Introduction	17
5.2.2	Acceptable Means for Performance Verification	17
5.2.2.1	Pass/Fail Criterion	19
6	MEMBERSHIP	25

TABLE OF FIGURES

Figure 2-1:	Coexistence Scenario	7
Figure 2-2:	Block Diagram of an Exemplary WAIC System	8
Figure 5-1:	Assessment positions for aircraft WAIC power spectral flux density	14
Figure 5-2:	Top view of hemisphere with radius R_1	15
Figure 5-3:	Front view of exemplary assessment positions on hemisphere of radius R_1	15
Figure 5-4:	Interference Signal Source Locations on Circle of Radius R_2	18
Figure 5-5:	Radio Altimeter Test Signal	18
Figure D-1:	Geometries of Parking Scenario	D.1

TABLE OF TABLES

Table 5-1:	WAIC Test Signal Characteristics	19
Table 5-2:	Radio Altimeter test signal characteristics	19

1 PURPOSE AND SCOPE

1.1 INTRODUCTION AND PURPOSE OF DOCUMENT

This document contains Minimum Aviation System Performance Standards (MASPS) for coexistence of Wireless Avionics Intra-Communication (WAIC) systems operating within the 4200-4400 MHz radio frequency band. The term WAIC refers to a broad class of on-board wireless communication systems intended to provide data links between various aircraft functions [1]. This document provides designers of WAIC systems with guidance on how to demonstrate coexistence of WAIC systems with aircraft systems installed on board other aircraft using the same radio frequency spectrum between 4200 MHz and 4400 MHz. These other aircraft systems are radio altimeter systems (radio altimeters) and WAIC systems on board other aircraft.

The notion of WAIC was first introduced when the aviation industry requested the International Telecommunication Union (ITU) to introduce a new frequency spectrum allocation to enable operation of wireless data links on board aircraft related to safety and regularity of flight. Resolution 424 of the 2015 World Radiocommunication Conference (WRC-15) [2] defined WAIC as “radiocommunication between two or more aircraft stations located on board a single aircraft, supporting the safe operation of the aircraft”. The conference added to the Table of Frequency Allocations of the Radio Regulations (RR) a new Aeronautical Mobile (Route) Service – AM(R)S – allocation in the frequency band 4200-4400 MHz, which is reserved exclusively for WAIC. Per Article 1.33 of the RR, the aeronautical mobile (R) service is reserved for communications related to safety and regularity of flight. Thus, uses not related to the safety and regularity of flight such as in-flight entertainment or passenger connectivity are expressly excluded from the scope of WAIC. The restriction of WAIC to safety and regularity of flight related uses, in the absence of existing certification guidance, has created a need to develop such guidance for this new class of aircraft systems.

The need to address WAIC coexistence performance stems from the fact that the frequency band 4200-4400 MHz also contains a preexisting allocation to the Aeronautical Radio Navigation Service – ARNS – reserved exclusively for radio altimeters [2], [3]. ITU-R studied the coexistence between WAIC and radio altimeters within ITU-R Report M.2319. In particular, emission limits were reported in Table A-1.7. The new allocation for WAIC was introduced under the condition that the use of WAIC cannot disrupt or degrade the operation of radio altimeters. Resolution 424 (WRC-15) [2], derived from ITU-R compatibility studies [9] and expressed with the Recommendation ITU-R M.2085 [10], expressly states that WAIC shall not cause harmful interference to, nor claim protection from, radio altimeters.. This in effect grants priority to the ARNS allocation used by radio altimeters. It poses a requirement on WAIC system designers to assure protection of radio altimeters, without creating any corresponding reciprocal requirement on radio altimeter designers. The purpose of this MASPS is to provide WAIC system designers with acceptable means of demonstrating such protection.

Furthermore, this document is intended to establish an acceptable means of compliance for WAIC systems in accordance with the requirements in the Standards and Recommended Practices (SARPs) for WAIC developed by the International Civil Aviation Organization (ICAO). As part of World Radiocommunication Conference 2015, Resolution 424 mandated that WAIC must comply with ICAO SARPs, which are currently in development. The crucial aspects of these SARPs are that WAIC systems:

- shall not interfere with radio altimeters on other aircraft,
- shall not interfere with WAIC systems on other aircraft,
- shall tolerate radio emissions from radio altimeters on other aircraft.

Further detail on the above aspects can be found in the relevant sections of this document.

This MASPS provides a consistent and acceptable means of compliance to be used in conjunction with requirements established in the forthcoming ICAO SARPs.

1.2 SCOPE OF THE DOCUMENT

This document addresses the coexistence aspects of WAIC that arise from the use of the frequency band 4200-4400 MHz. Aspects that are addressed are:

- A. that a WAIC system does not cause harmful interference to radio altimeters on board other aircraft,
- B. that a WAIC system does not cause harmful interference to WAIC systems on board other aircraft,
- C. that a WAIC system performs its intended function in the presence of radio emissions from radio altimeters on board other aircraft,
- D. that a WAIC system performs its intended function in the presence of radio emissions from WAIC systems on board other aircraft.

The issue A above stems directly from Resolution 424 (WRC-15) [2] giving radio altimeters priority over WAIC systems. The issues B, C and D stem from WAIC being related to safety and regularity of flight and the resulting need to assure they can operate in the presence of other users of the band, namely radio altimeters and WAIC systems on board other aircraft.

The issues A and B above are addressed in this MASPS by the introduction of limits on the emitted RF power (power spectral flux density and total power flux density) of a WAIC system installed on board an aircraft, as specified by the requirement PR#1. PR#1 is comprised of two requirements, PR#1a and PR#1b, (see section 3.4.1.2). The power limits assure that the interference power received by radio altimeters and WAIC systems on board other aircraft will not cause any degradation of performance for those systems. The issues C and D above are addressed by introducing the requirement PR#2 (see section 3.4.1.2) and the associated interference susceptibility of WAIC systems. Jointly, the requirements PR#1 and PR#2 assure coexistence of a WAIC system installed on board the aircraft that is undergoing certification with radio altimeters and WAIC systems on board other aircraft.

This MASPS does not address the coexistence of WAIC systems with radio altimeters on board the same aircraft. As all systems on board a single aircraft are under the control of the aircraft-level system integrator, coexistence on board the same aircraft can be assured and demonstrated by various appropriate means that need not be constrained by this standard. Therefore, this aspect is out of scope of this document.

For the same reason this MASPS does not address the coexistence of different WAIC communication links on board the same aircraft. Throughout this document, a WAIC system is understood as the entirety of all WAIC components on board the same aircraft. That is, a single aircraft contains only a single WAIC system. Assuring that different components of a single WAIC system can coexist is assumed to be the responsibility of the aircraft-level system integrator and is out of scope of this document.

This MASPS does not address the issue of how to define and quantify the intended function of a WAIC system. It is expected that WAIC will serve various aircraft functions which will place different requirements on the wireless communication links. In broad terms, it is understood that the intended function of a WAIC system is to satisfy the data transfer requirements of all the aircraft functions it serves. It is impossible, however, to define precisely what those requirements will be, as different aircraft functions may be architected to use WAIC data links differently. Also, different WAIC system designers may assure data link availability and quality in different ways. These issues are out of scope of this document.

Finally, this MASPS does not address the issue of WAIC system interoperability. From the aircraft-level system integrator perspective, it may be advantageous to have some form of interoperability between WAIC components on board the same aircraft. In the extreme, however, a WAIC system on board a single aircraft could be a collection of dissimilar point-to-point data links (that are not interoperable), each with its own protocols and access rules. This MASPS does not presuppose which particular WAIC

system architecture is chosen and whether data links are interoperable. This issue is out of scope of this document.

1.3 STRUCTURE OF THE DOCUMENT

Section 1 (the current section) provides an explanation of the scope and purpose of this document and introduces the concept of WAIC systems.

Section 2 describes the approach and methodology applied for the development of this minimum performance standard for the coexistence of WAIC systems.

Section 3 describes minimum system performance requirements for WAIC systems derived to assure safe coexistence of WAIC and radio altimeters within the same radio frequency band. The section also includes the key assumptions made for WAIC systems.

Section 4 is reserved, due to interoperability requirements being out of scope of this document.

Section 5 describes performance verification factors to be addressed to verify that a WAIC system meets the minimum performance requirements in Section 3.

Appendix A is the Operational Services and Environment Definition (OSD) for the WAIC system. This Appendix is reserved.

Appendix B is the Operational Performance Assessment (OPA) for the WAIC system. This Appendix is reserved.

Appendix C provides the Collision Risk Model (CRM)/Comparative Analysis for the WAIC system. This Appendix is reserved.

Appendix D provides the geometric configurations of multiple aircraft at an airport that were used to define the worst-case coexistence scenarios for the derivation of performance requirements in Section 3.

Appendix E is an acknowledgement to the work done by AVSI in support of the creation of this MASPS.

NOTE: *Some sections of this document are marked as “Reserved” to maintain consistency in the numbering scheme of EUROCAE and RTCA MASPS.*

1.4 RELATIONSHIP TO ICAO DOCUMENTS

The Frequency Spectrum Management Panel (FSMP) of ICAO was tasked to develop the SARPs for WAIC, per ITU's request as expressed in Resolution 424 (WRC-15), to be eventually included in Annex 10 to the Convention on International Civil Aviation.

The forthcoming WAIC SARPs addresses WAIC coexistence issues. These MASPS provide corresponding acceptable means of compliance.

The availability of SARPs for WAIC is a necessary condition for the operation of WAIC as part of the aeronautical mobile (R) service, per Resolution 424 (WRC-15).

1.5 AIRWORTHINESS SECURITY AS IT APPLIES TO WAIC

Airworthiness security is the protection of the airworthiness of an aircraft from intentional unauthorized electronic interaction. Applicants intending to install WAIC systems must address intentional disruption in their design and installation safety processes to comply with aircraft network security regulations. Intentional unauthorized electronic interaction is defined as a circumstance or event with the potential to affect the aircraft due to human action resulting from unauthorized access, use, disclosure, denial, disruption, modification, or destruction of information and/or aircraft system interfaces. This includes the consequences of malware and forged data and the effects of external systems on aircraft systems but does not include physical attacks or electromagnetic disturbance.

WAIC will provide a means of aircraft intra-communications using a wireless connection in lieu of or as a backup to the traditional physical wiring. Wireless systems will require

different security measures and considerations from wired systems. Therefore, it is important that manufacturers consider airworthiness security risk mitigation strategies in their equipment design. It is recommended that WAIC equipment manufacturers review the relevant RTCA/EUROCAE standards focusing on Aircraft Systems Information Security/Protection (ASISP), which are listed as items [6], [7], and [8] in section 1.6 below.

1.6 REFERENCES

Ref	Title	Author	Year
[1]	Report ITU-R M.2283-0: Technical characteristics and spectrum requirements of wireless avionics intra-communications systems to support their safe operation.	ITU-R	2013
[2]	The Radio Regulations edition of 2016	ITU-R	2016
[3]	Recommendation ITU-R M.2059-0: Operational and technical characteristics and protection criteria of radio altimeters utilizing the band 4 200-4 400 MHz	ITU-R	2014
[4]	Annex 14 to the Convention on International Civil Aviation, Volume 1 Aerodrome Design and Operations	ICAO	2009
[5]	Airport development reference manual	IATA	2004
[6]	RTCA DO-356A / EUROCAE ED-203A - Airworthiness Security Methods and Considerations	RTCA / EUROCAE	2018
[7]	RTCA DO-355 / EUROCAE ED-204 – Information Security Guidance for Continuing Airworthiness	RTCA / EUROCAE	2014
[8]	RTCA DO-326A / EUROCA ED-202A – Airworthiness Security Process Specification	RTCA / EUROCAE	2014
[9]	Report ITU-R M.2319-0: Compatibility analysis between wireless avionic intra-communication systems and systems in the existing services in the frequency band 4 200-4 400 MHz	ITU-R	2014
[10]	Recommendation ITU-R M.2085-0: Technical conditions for the use of wireless avionics intra-communication systems operating in the aeronautical mobile (R) service in the frequency band 4 200-4 400 MHz	ITU-R	2015
[11]	Recommendation ITU-R M.2067-0: Technical characteristics and protection criteria for Wireless Avionics Intra-Communication systems	ITU-R	2014

1.7 ACRONYMS

AVSI	Aerospace Vehicle Systems Institute
CRM	Collision Risk Model
EIRP	Equivalent Isotropic Radiated Power
FSMP	Frequency Spectrum Management Panel
ICAO	International Civil Aviation Organization
ITU	International Telecommunication Union
MASPS	Minimum Aviation System Performance Standard
MOPS	Minimum Operational Performance Standards
OPA	Operational Performance Assessment
OSD	Operational Services and Environment Definition
PR	Performance Requirement

RR	Radio Regulations
SARPs	Standards and Recommended Practices
TSO	Technical Standard Orders
WAIC	Wireless Avionics Intra-Communication
WRC	World Radiocommunication Conference

2 APPROACH AND METHODOLOGY

2.1 DOCUMENT DEVELOPMENT PROCESS

The requirements provided in the initial version of this MASPS were based on studies performed and documented under the ITU that established limits on the maximum equivalent isotropically radiated power (EIRP) spectral density generated by WAIC systems. The technical characteristics and spectrum requirements of future WAIC systems were studied in Report ITU-R M.2283, which proposed maximum power spectral density of approximately 10mW/2.6MHz (equivalent to 4 mW/MHz or 6 dBm/MHz). That transmit power limitation was later adopted by Recommendation ITU-R M.2067 for use in all future sharing and compatibility studies involving WAIC. Coexistence between WAIC and radio altimeters was then studied in Report ITU-R M.2319 and, based on that study, Recommendation ITU-R M.2085 specified that the maximum EIRP density generated by WAIC systems aboard an aircraft should not exceed 6 dBm/MHz in order to protect radio altimeters. These requirements were thus adopted under WRC-15 Resolution 424 and are now codified in the international Radio Regulations.

The first step to verify the coexistence between radio altimeters and WAIC systems in all phases of flight given this transmitted power limit was to establish the susceptibility of radio altimeters to interference from WAIC systems through laboratory testing of a representative set of radio altimeter designs. This set was only based on Frequency Modulation Continuous Wave (FMCW) radio altimeters that are commonly installed on transport category airplanes / large aeroplanes. Interference path loss characterization was performed via ground tests involving multiple aircraft. The Aerospace Vehicle Systems Institute (AVSI) performed these tests under a cooperative research project that included subject matter experts from radio altimeter developers, aircraft integrators, aircraft systems developers, and academic and government research organizations.

Based on ITU documents and validated by these measurement results and further analysis, WG-96 and SC-236 iteratively developed the performance requirements in this document. All aircraft assessment performance verification factors to be addressed were peer reviewed for accuracy and applicability. Several rounds of testing were accomplished with the results used to update the aircraft assessment performance verification factors. Once the aircraft assessment performance verification factors were baselined, performance requirements PR#1a and PR#2 in section 5 were agreed upon. Testing validated the requirements and the specific values provided in this document, namely the assertion that if WAIC emissions from a single aircraft do not exceed the limits prescribed in PR#1a, then operation of radio altimeters on board other aircraft will not be affected. Therefore, SC-236 and WG-96 conclude that WAIC systems installed in aircraft that comply with PR#1a and PR#2 ensure non-interference with other systems and contribute to aviation safety.

It has to be noted that the first version of this MASPS only focused on the EIRP limitation of 6dBm/MHz for WAIC emissions. It was documented by ITU, and in particular within the Report ITU-R M.2319, that this limitation is not sufficient to ensure the protection of the radio altimeters (defined by the Recommendation ITU-R M.2059). Therefore, in order to ensure the protection of these radio altimeter, PR#1b was amended. PR#1b specifies a total EIRP limit for a WAIC system when installed on an aircraft of -20dBm.

2.2 METHODOLOGY (RESERVED)

2.2.1 Operational Services and Environment Definition (OSED) (Reserved)

2.2.2 System Performance Requirements

The term WAIC was first introduced in the course of the international aviation industry's effort to introduce appropriate provisions into the Radio Regulations (RR) [2] supporting the use of radio communication for interconnecting aircraft systems, their subsystems and/or components thereof. Resolution 424 of World Radiocommunication 2015 (WRC-15) [2] states that: