Revision 1 changes are highlighted in Turquoise

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| **U.S. Radiocommunications Sector****Fact Sheet** |
| **Working Party:** ITU-R WP-5B | **Document No:** USWP5B25-08 (Rev 1) |
| **Ref:** Document 5B/76 | **Date:** 7 October 2020 |
| **Document Title:** WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT NEW RECOMMENDATION ITU-R M.[15.4-15.7\_GHz\_ARNS] - Characteristics of and protection criteria for the aeronautical radionavigation service in the frequency band 15.4-15.7 GHz |
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| **Purpose/Objective:** The purpose of this contribution is to continue to develop a new recommendation for aeronautical radionavigation systems, including unmanned aircraft systems (UAS) Detect and Avoid (DAA) radar systems, in the 15.4-15.7 GHz band. This contribution will be an update to Document 5B/76 that was carried over from the last WP-5B meeting. |
| **Abstract:** This contribution will continue the process of developing a new recommendation containing characteristics of and protection criteria for systems that operate in the 15.4-15.7 GHz aeronautical radionavigation service allocation including UAS DAA systems. |

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| **Radiocommunication Study Groups** |  |
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| Received: XX October 2020Source: NoneSubject: New Recommendation for DAA radar | **Document 5B/XXX-E** |
| **7 October 2020** |
| **English only** |
| United States of America |
| WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT NEW  RECOMMENDATION ITU-R M.[15.4-15.7\_GHz\_ARNS][[1]](#footnote-1)\* |
| Characteristics of and protection criteria for radars operating in the aeronautical radionavigation service in the frequency band 15.4-15.7 GHz |

(202X)

Introduction

This proposed new Recommendation is intended to provide characteristics and protection criteria for aeronautical radionavigation systems, including unmanned aircraft (UA) Detect and Avoid (DAA) radar system operating in the aeronautical radionavigation service (ARNS) in the frequency band 15.4-15.7 GHz. These technical and operational characteristics are to be used as a guideline in analyzing compatibility between radars operating in the aeronautical radionavigation service and systems in other services within this band.

Proposal

To provide the necessary characteristics for sharing studies with other systems in this band.

**Attachment**: 1

ATTACHMENT

WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT NEW
RECOMMENDATION ITU-R M.[15.4-15.7\_GHz\_ARNS]

Characteristics of and protection criteria for radars operating in the
aeronautical radionavigation service in the frequency
band 15.4-15.7 GHz

(202X)

Scope

This Recommendation specifies the characteristics and protection criteria of radars operating in the aeronautical radionavigation service (ARNS) in the frequency band 15.4-15.7GHz. The technical and operational characteristics should be used in analysing compatibility between radars operating in the aeronautical radionavigation service and systems in other services.

Keywords

15.4-15.7 GHz, radar, characteristics, protection.

Abbreviations/Glossary

ARNS Aeronautical radionavigation service

DAA Detect and Avoid

e.i.r.p Effective Isotropically Radiated Power

GBSS Ground Based Surveillance System

PSD Power Spectral Density

UA Unmanned aircraft

UAS Unmanned aircraft system

The ITU Radiocommunication Assembly,

considering

*a)* that antenna, signal propagation, target detection, and wide necessary bandwidth of radar required to achieve their functions are optimum in certain frequency bands;

*b)* that the technical characteristics of radars operating in the aeronautical radionavigation service (ARNS) are determined by the mission of the system and vary widely even within a frequency band,

recognizing

*a)* that the frequency band 15.4-15.7 GHz is allocated on a primary basis to aeronautical radionavigation, and radiolocation services, and that the fixed-satellite service (Earth-to-space) is also allocated on a primary basis in the band 15.43-15.63 GHz;

*b)* that the radiolocation services operating in the frequency band 15.4-15.7 GHz shall not cause harmful interference to, or claim protection from the aeronautical radionavigation service;

*c)* that the fixed-satellite service (Earth-to-space) operating in the frequency band 15.43‑15.63 GHz is limited to feeder links of non-geostationary systems in the mobile-satellite service, and is subject to coordination under No. **9.11A**

*d)* that stations operating in the aeronautical radionavigation service shall limit the effective e.i.r.p. in accordance with Recommendation ITU-R S.1340-0;

*e)* that for stations operating in the fixed-satellite service (Earth-to-space), the minimum coordination distance required to protect the aeronautical radionavigation stations (No. 4.10 applies) from harmful interference from feeder-link earth stations and the maximum e.i.r.p. transmitted towards the local horizontal plane by a feeder-link earth station shall be in accordance with Recommendation ITU-R S.1340-0,

recommends

**1** that the technical and operational characteristics of the radars operating in the ARNS described in the Annex should be considered representative of those operating in the frequency band 15.4-15.7 GHz and used in studies of compatibility with systems in other services;

**2** that the criterion of interfering signal power to radar receiver noise power level (*I*/*N)* of [‑6 dB/‑10 dB], should be used as the required protection level for the aeronautical radionavigation radars, and that this represents the aggregate protection level if multiple interferers are present.

Annex

Technical and operational characteristics of radars operating in the
aeronautical radionavigation service in the
frequency band 15.4-15.7 GHz

# 1 Introduction

ARNS system operates worldwide on a primary basis in the frequency band 15.4-15.7 GHz. This Annex presents the technical and operational characteristics of representative ARNS radars operating in this frequency band.

ARNS systems are installed in unmanned aircraft (UA) or on the ground to detect non-cooperative aircraft as a component of an UA Detect and Avoid (DAA) system. The RTCA (formally known as Radio Technical Commission for Aeronautics) has developed a minimum operational performance standard for the airborne equipment “*DO-366 – Air-to-Air Radar for Traffic Surveillance*” and for the ground equipment “*DO-381 – Ground Based Surveillance System (GBSS) for Traffic Surveillance*”. These radars are used for collision avoidance on-board UA and are a vital part of the integration of unmanned aircraft system (UAS) in non-segregated airspace.

# 2 Characteristics of aeronautical radionavigation Detect and Avoid radar

The safe flight operation of UA necessitates advanced techniques to detect and track nearby aircraft, terrain, and obstacles to navigation. UA must avoid these objects in the same manner as manned aircraft. The remote pilot will need to be aware of the environment within which the aircraft is operating, be able to identify the potential threats to the continued safe operation of the aircraft, and take the appropriate action. The DAA radar is part of an unmanned aircraft collision avoidance system whose primary function is to provide the capability to detect, track and report non-cooperative air traffic information to the remote pilot in order to maintain adequate separation from intruders. The system utilizes a “Pilot-in-the-Loop” approach in which the ground-based UA pilot will have final authority regarding UAS manoeuvers to avoid other aircraft (manned or unmanned). The technical parameters are provided in Table 1.

TABLE 1

Technical parameters of Detect and Avoid radar

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Radar 1 | Radar 2 |
| Platform |  | Aircraft | Ground |
| Platform height  | km | Up to 20 | 0 |
| Radar type |  | Air-to-air radar for UA DAA system | Ground surveillance radar for UA DAA system  |
| Ground speed  | km/h | [TBD] | 0 |
| Frequency tuning range  | GHz | 15.4-15.7 | 15.4-15.7 |
| Emission type |  | [TBD] | [TBD] |
| Pulse width  | μs | [TBD] | [TBD] |
| Pulse rise and fall times  | ns | [TBD] | [TBD] |
| RF emission bandwidth at -3 dB-20 dB-40 dB | MHz | [TBD][TBD][TBD] | [TBD][TBD][TBD] |
| Pulse repetition frequency | pps | [TBD] | [TBD] |
| Average transmitter power  | W | [TBD] | [TBD] |
| Receiver IF bandwidth-3 dB-20 dB-60 dB | MHz | [TBD][TBD][TBD] | [TBD][TBD][TBD] |
| Sensitivity | dBm | [TBD] | [TBD] |
| Receiver noise figure | dB | [TBD] | [TBD] |
| Calculated Rx noise power | dBW | [TBD] | [TBD] |
| Antenna type |  | [TBD] | [TBD] |
| Antenna placement |  | [TBD] | [TBD] |
| Antenna gain | dBi | [TBD] | [TBD] |
| First antenna side lobe | dBi | [TBD] | [TBD] |
| Horizontal beamwidth | degrees | [TBD] | [TBD] |
| Vertical beamwidth | degrees | [TBD] | [TBD] |
| Polarization |  | [TBD] | [TBD] |
| Antenna scan | degrees | [TBD] | [TBD] |
| Protection criteria | dB | [TBD] | [TBD] |

# 3 Characteristics of aeronautical radionavigation landing system

This system is an electronic landing aid that provides flight path data to an approaching aircraft as the aircraft flies into range of the landing system. There are two separate surface transmitters, one for azimuth and one for elevation, as well as a receiver installed on the aircraft. The system utilizes a one way transmission where the angular information is displayed on a cross-point indicator allowing the aircraft to align itself with the runway.

The technical parameters are provided in Table 2.

TABLE 2

Technical parameters of landing system

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Landing System Transmitter | Landing System Receiver |
| Platform |  | Land/Ship  | Aircraft |
| Platform height  | km | Land : 0.01Ship: 0.015-0.024 | Maximum: 2 |
| Ground speed  | km/h | Land : 0Ship : < 50 | < 350 |
| Frequency tuning range  | GHz | 15.4-15.7 | 15.4-15.7 |
| Emission type |  | Pulse | Not applicable |
| Pulse width  | μs | 0.3 | Not applicable |
| Pulse rise and fall times  | ns | Rise Time : 25-50; Fall Time : 25-200 | Not applicable |
| RF emission bandwidth at -3 dB-20 dB-40 dB | MHz | 4.818.565 | Not applicable |
| Pulse repetition frequency | pps | 15000 | Not applicable |
| Average transmitter power  | W | Peak: 2500; Average: 7 | Not applicable |
| Receiver IF bandwidth at-3 dB-20 dB-60 dB | MHz | Not applicable | 121724 |
| Sensitivity | dBm | Not applicable | -72 |
| Receiver noise figure | dB | Not applicable | 11.5 |
| Calculated Rx noise power | dBW | Not applicable | -121.7 |
| Antenna type |  | Parabolic Reflector | Horn |
| Antenna placement |  | Ground/Surface | Bottom of aircraft |
| Antenna gain | dBi | Horizontal: 32; Vertical: 26 | 6 |
| First antenna side lobe | dBi | At least 17 dB below peak | At least 17 dB below peak |
| Horizontal beamwidth | degrees | Horizontal: 40; Vertical: 2 | 70 |
| Vertical beamwidth | degrees | Horizontal: 1.3; Vertical: 6 | 36 |
| Polarization |  | Vertical | Vertical |
| Antenna scan | degrees | Sector Scan | Fixed |
| Protection criteria | dB | -10 | -10 |

# 4 Protection criteria

The desensitizing effect on radars from other services of a continuous-wave or noise-like type modulation is predictably related to its intensity. In any azimuth sectors in which such interference arrives, its power spectral density (PSD) can, to within a reasonable approximation, simply be added to the PSD of the radar receiver thermal noise. If PSD of radar‑receiver noise in the absence of interference is denoted by *N*0 and that of noise-like interference by *I*0, the resultant effective noise PSD becomes simply *I*0 + *N*0.

***Editor’s note:*** *more information on the appropriate protection criteria will be provided once the technical and operational characteristics of radars in section 2 have been finalized.*

• For typical radars an increase of about 1 dB would constitute significant degradation, equivalent to a detection-range reduction of about 6%. Such an increase corresponds to an *I/N* ratio of 1.26, or an I/N ratio of about −6 dB.

• For the radionavigation service considering the safety-of-life function, an increase of about 0.5 dB would constitute significant degradation. Such an increase corresponds to an (*I/N*) ratio of −10 dB.

These protection criteria represent the aggregate effects of multiple interferers, when present; the allowable *I*/*N* ratio for an individual interferer depends on the number of interferers and their geometry, and needs to be assessed in the course of analysis of a given scenario. The aggregation factor can be very substantial in the case of certain communication systems in which a great number of stations can be deployed.

1. \* This Recommendation should be brought to the attention of the International Civil Aviation Organization (ICAO). [↑](#footnote-ref-1)