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| U.S. Radiocommunications Sector  Fact Sheet | |
| **Working Party:** ITU-R WP-5B | **Document No:** USWP5B34-07 |
| **Ref:** Annex 25 to Document 5B/216-E | **Date:** 25 February 2025 |
| **Document Title:** **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. | |
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| **Purpose/Objective:** The purpose of this contribution is 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 update and/or address comments on the technical parameters of DAA radars in Table 1 and Table 2 as applicable. Due to the stability of the technical characteristics data for the airborne and ground based DAA system this contribution proposes to upgrade the Working Document into Preliminary Draft New Recommendation. This contribution will be an update to the new report found in Annex 25 of the Chairman’s Report of the 28 November 2025 Document 5B/216-E meeting. | |
| **Abstract:** This contribution is a new recommendation for UAS Detect and Avoid (DAA) systems that operate in the 15.4-15.7 GHz Aeronautical Radionavigation Service allocation. This contribution contains characteristics and protection criteria for UAS DAA radar that can be used both on the airborne and grounds platforms. | |

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| **Radiocommunication Study Groups** |  |
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**United States of America**

CHARACTERISTICS OF AND PROTECTION CRITERIA FOR RADARS   
OPERATING IN THE AERONAUTICAL RADIONAVIGATION SERVICE IN   
THE FREQUENCY BAND 15.4-15.7 GHz

Introduction

This document proposes new Recommendation with 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

The United States proposes that ITU-R Working Party (WP) 5B consider the updates to the working document towards a preliminary draft New Recommendation [ITU-R M.[15.4-15.7\_GHz\_ARNS]](https://www.itu.int/dms_ties/itu-r/md/23/wp5b/c/R23-WP5B-C-0216!N25!MSW-E.docx) attached to the Chairman’s Report. The proposed updates seek to address the editor’s notes and square brackets in this document.

The United States proposals are highlighted in bright Green. It is also proposed to elevate the status of this document to Preliminary Draft New Recommendation.

**Attachment:** 1

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| 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 / airborne detect and avoid and aircraft landing systems] 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 [onboard airborne] detect and avoid radars and landing systems operating in the aeronautical radionavigation service (ARNS) in the frequency band 15.4-15.7 GHz.

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

ESA Electronically scanned array

FMCW Frequency-modulated continuous wave

LFM Linear frequency modulation

PSD Power spectral density

RCS Radar cross-section

RR Radio Regulations

SNR Signal-to-noise power ratio

UAS Unmanned aircraft system

Related ITU Recommendations and Reports

Recommendations

[ITU-R M.1372](https://www.itu.int/rec/R-REC-M.1372/en) *Efficient use of the radio spectrum by radar stations in the radiodetermination service*

[ITU-R M.1730](https://www.itu.int/rec/R-REC-M.1730/en) *Characteristics of and protection criteria for the radiolocation service in the frequency band 15.4-17.3 GHz*

[ITU-R S.1340](https://www.itu.int/rec/R-REC-S.1340/en) *Sharing between feeder links for the mobile-satellite service and the aeronautical radionavigation service in the Earth-to-space direction in the band 15.4-15.7 GHz*

Report

[ITU-R M.2204](https://www.itu.int/pub/R-REP-M.2204) Characteristics and spectrum considerations for sense and avoid systems use on Unmanned Aircraft Systems (UAS)

The ITU Radiocommunication Assembly,

considering

*a)* that the technical characteristics of detect and avoid radars operating in the aeronautical radionavigation service (ARNS) are driven by the performance requirement and depend on the frequency band;

*b)* that the performance characteristics of receivers should be adequate to ensure that they do not suffer from interference due to transmitters situated at a reasonable distance and which operate in accordance with the Radio Regulations,

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 frequency 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 aeronautical radionavigation service is a safety service as specified by No. **4.10** of the Radio Regulations (RR);

*d)* Techniques for suppression of low-duty cycle pulsed interference between two or more pulsed system are contained in Recommendation ITU-R M.1372 – Efficient use of the radio spectrum by radar stations in the radiodetermination service;

*e)* 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 RR No. **9.11A**;

*f)* that the limit of effective isotropically radiated power (e.i.r.p) of stations operating in the aeronautical radionavigation service is provided in Recommendation ITU-R S.1340;

*g)* that for stations operating in the fixed-satellite service (Earth-to-space), the minimum coordination distance required to protect the aeronautical radionavigation stations (RR 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 are provided in Recommendation ITU-R S.1340-0;

*h)* that the frequency band 15.4-15.7 GHz is allocated worldwide on a primary basis to the aeronautical radionavigation service;

*i)* that the frequency band 15.4-15.7 GHz is also allocated worldwide on a primary basis to the radiolocation service and RR No. **5.511E** states that stations operating in the radiolocation service shall not cause harmful interference to, or claim protection from, stations operating in the aeronautical radionavigation service;

*j)* that the frequency range 15.4-15.7 GHz is also allocated on a secondary basis to the aeronautical mobile (OR) service by RR Nos. **5.511G** and **5.511H**,

recommends

1 that the technical and operational characteristics of the detect and avoid radar and landing systems operating in the ARNS described in the annex should be considered in studies of sharing and 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, should be used as the required protection level for the detect and avoid radars and landing systems, and that this represents the aggregate protection level if multiple interferers are present[[1]](#footnote-1).

Annex  
  
Technical and operational characteristics of [radars / airborne detect and avoid and aircraft landing systems] operating in the  
aeronautical radionavigation service in the  
frequency band 15.4-15.7 GHz

# A1 Introduction

This annex presents the technical and operational characteristics of representative ARNS radars operating in the 15.5-15.7 GHz frequency band.

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Some ARNS systems are installed in unmanned aircraft (UA) or on the ground to detect non-cooperative aircraft as a surveillance system contributing to the UA detect and avoid (DAA) system.

Some ARNS systems are used for landing.

**A1-1 Characteristics of detect and avoid radars**

The technical parameters are provided in Table A1-1.

TABLE A-1

[Editor’s note: The highlights and edit marks in the table and associated notes below need to be maintained in order to facilitate the ongoing work of populating this table.]

Representative technical parameters of radionavigation radar

| Parameter | Units | Radar 1 (Note 1) | Radar 2 (Note 1) | Radar 3 Note 1 | Radar 4 | Radar 5 | Radar/DAA 6 (Note 1) |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Platform  (Note 1) |  | Airborne | Airborne | Airborne | Airborne | Airborne | Airborne |
| Platform height  (Note 1) | km | Up to 12 | Up to 12 | Up to 12 | Up to 15 | Up to 15 | Up to 10 |
| Radar type |  | FMCW | FMCW | Pulse-Doppler | Pulse Modulation | Pulse Modulation | FMCW |
| Operating range | km | 0.8 (small UAS) 2.0 (small General Aviation aircraft (GA)) | 1.8 (small UAS) 4.5 (small General Aviation aircraft) | 9 | 5 | 10 | 4 (small UAS)  13 (small General Aviation aircraft) |
| Maximum number of DAA system within the same operating area |  | 10 | 10 | 3 to 12 | Up to 10 | Up to 20 | 10 |
| Relative to Air speed  (Note 2) | km/h | 50-100 (small UAS)  200 (small GA) | 50-100 (small UAS)  200 (small GA) | 700 |  |  | 50-100 (small UAS)  200 (small GA) |
| m/s\* |  |  |  | Up to 150 | Up to 150 |  |
| **Transmitter** | | | | | | |  |
| Frequency tuning range | GHz | 15.4-15.7 (Note 3) | 15.4-15.7 (Note 3) | 15.4-15.7 (Note 4) | 15.4-15.7 | 15.4-15.7 | 15.4-15.7 (Note 3) |
| Channel selection method between radars |  | (Note 3) | (Note 3) | SW selectable (Note 5) | SW selectable (Note 5) | SW selectable (Note 5) | (Note 3) |
| Pulse width (1 meter range resolution) | μs | 239 | 239 | 0.25 to 20  (Note 6) | 1 to 20 | 1 to 20 | 239 |
| Pulse rise and fall times | μs | 5/5 | 0.5/0.5 | 0.025/1.5 | < 0.1 | < 0.1 | 0.5/0.5 |
| RF emission bandwidth   −3 dB  −20 dB  −40 dB | MHz | 176  184  201 | 152  164  269 | (Band 1-MHz)  25  80  155 | 80  90  110 | 80  90  110 | 152  164  269 |
| Pulse repetition frequency | PPS  OR  Hz | 4 000 | 4 000 | 5000-200000  (Note 7) | - | - | 4 000 |
| Pulse repetition interval | μs | 250 | 250 | 14.30 – 114.03  (Note 7) | 30 to 80 | 30 to 80 | 250 |
| Average transmitter power (conducted) during emission time | W | 2 | 10 | 30 | 70 | 100 | 20 |
| Out-of-band emission characteristics | dBc | 60 | 63 | 75 (through 3rd harmonic) | - | - | 63 |
| Spurious emission characteristics (conducted) | dBc | −72 | −87 | −60 | SM.329 | SM.329- | −87 |
| **Receiver** | | | | | | |  |
| Receiver IF bandwidth  −3 dB  −20 dB  −60 dB | MHz | 15  32  58 | 15  32  58 | 53  70  114 | 20  40  80 | 20  40  80 | 15  32  58 |
| Sensitivity | dBm | −147  (Note 8) | −141  (Note 8) | −121  (Note 8) | (Note 8) | TBD  (Note 8) | −141 |
| Receiver noise figure | dB | 1.5 | 1.5 | 4 | 3 | 3 | 1.5 |
| Calculated Rx noise power | dBW | -130.7 | -130.7 | -1339) | - | - | −131 |
| Saturation level | dBW/m2 | -35 | -30 | -40 |  |  | −30 |
|  |  |  |  |  |  |  | −177 |
| Protection criteria (aggregate) *I/N* | dB | −6 | −6 | −6 | −6 | −6 |  |
| **Antenna** | | | | | | |  |
| Antenna type |  | AESA (Note 10) | AESA (Note 10) | ESA (Note 10) | MIMO | MIMO | AESA  (Note 10) |
| Antenna pattern | N.A. | N/A | N/A | N/A | See Annex 2 | See Annex 2 | N/A |
| Antenna placement (Note 1) |  | Aircraft | Aircraft | Aircraft | Aircraft | Aircraft | Aircraft (manned  or unmanned) |
|  |  |  |  |  |  |  |  |
| Maximum antenna gain | dBi | 14 | 15 | 27 | 9 | 9 | 15 |
| Antenna pointing | TBD | N/A | N/A | N/A | TBD | TBD | N/A |
| First TX antenna side lobe | dBi | −17 at 50° | −15 at 50° | 25 at 8° (Vertical)  -25 at 14° (Horizontal) | TBD | TBD | −15 at 50° |
| Horizontal beamwidth | degrees | 40 | 32 | 4 | 80  (Note 11) | 80  (Note 11) | 32 |
| Vertical beamwidth | degrees | 40 | 28 | 2 | 80  (Note 11) | 80  (Note 11) | 28 |
| Polarization |  | Vertical | Horizontal | Horizontal | Vertical | Vertical | Horizontal |
| Field of Regard | degrees | (Note 12) | (Note 12) | +/- 65°az  +50°/-40° el | +/-110° to +/-180° | +/-110° to +/-180° | (Note 12) |
| Horizontal Antenna scan | degrees | ±60 | ±60 | ±65 | - Not applicable | Not applicable- | ±60 |
| Vertical Antenna scan | degrees | ±20 | ±60 | −40, +50 | - Not applicable | - Not applicable | ±60 |
|  |  |  |  |  |  |  |  |
| Notes:  1 In some cases a UAS is unable to equip with airborne DAA. These radars can also be deployed on the ground in order to provide the intended DAA functions.  2 These radars have similar detection range on the same aircraft even if it flies at a different speed as long as the radar tracking software is expecting and designed for the correct aircraft speeds. What matters is radar cross section (RCS, i.e. “size”) of the target.  3 Radar is pre-programmed at the factory to any centre frequency inside this band. The set range resolution directly affects BW. Therefore, the range resolution will be a factor when programming the centre frequency, to ensure that the spectral power is within the 15.4 to 15.7 GHz band. For radars set with larger RR (i.e. smaller BW’s), multiple radars can be programmed and operated inside the 15.4 to 15.7 GHz band, allowing for coverage of larger areas. Also, these radars have the capability for multiple adjacent radars to be synchronized or to interleave their operations, so that they can operate on the same frequency.  4 Utilized bandwidth - Inclusive of frequency-channel guard-bands.  5 Channel selection is purely SW-defined and can be changed on-the-fly. Some settings may allow radar to self-configure based on detected spectrum-conflict.  6 Waveform is software-defined on a CPI-by-CPI basis, and optimized for targets, and spectral environments.  7 Based on the PRI, 8,769-69,917 pulses per second for PRR are more accurate. However, these radars are dynamic/cognitive radar and the PRI/PRR can be dynamically changed based on a number of characteristics (terrain, target, etc.) hence 5,000-200,000 PRR are listed.  8 MDS at RX input SNR = 12 dB.  9 Compressed bandwidth before processing gain.  10 For Radar 1, 2, and 6: Each radar has one TX array and one RX array integrated into their design. For radar 3: High T/R ESA RF beamforming on both transmit and receive.  11 For one panel at ‒3 dB.  12 These radars do not have multiple panel capability. Each radar has only one TX array and one RX array integrated into their design. Field or Regard (FOR) is programmable for each individual radar. For an individual radar, FOR can be programmed as wide as ±60°. However, four of these radars can be set up orthogonally to each other to achieve a FOR of 360°. | | | | | | | |

[Editor’s note: USA would like to retain Calculated Rx Noise Power and Saturation Level in Table 1 as these values will be needed for interference analysis calculations.]

# A1-2 Characteristics of 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 A1-2.

TABLE A1-2

Technical parameters of landing system

[Editor’s note: The highlights and edit marks in the table and associated notes below need to be maintained in order to facilitate the ongoing work of populating this table.]

| Parameter | Units | Transmitter | Receiver |
| --- | --- | --- | --- |
| Platform |  | Land/Ship | Aircraft |
| Platform height | km | Land: 0.01 Ship: 0.015-0.024 | Maximum: 2 |
| Relative to Air speed | m/s | Land: 0 Ship: < 14 | 98 |
| Number of aircraft per landing system |  | 1 | 1 |
| Transmitter | | | |
| 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 | 4.8  18.5  65 | Not applicable |
| Pulse repetition frequency | pps | 15 000 | Not applicable |
| Out-of-band emission characteristics | dBc | < 43 | Not applicable |
| Spurious emission characteristics | dBc | 65 | Not applicable |
| Average transmitter power | W | Peak: 2 500;  Average: 7 | Not applicable |
| Receiver | | | |
| Receiver IF bandwidth  −3 dB  −20 dB  −60 dB | MHz | Not applicable | 12  17  24 |
| Sensitivity | dBm | Not applicable | −72 |
| Receiver noise figure | dB | Not applicable | 11.5 |
| Calculated conducted Rx noise power | dBW | Not applicable | −121.7 |
| Image rejection | dB | Not applicable | 60 |
| Spurious rejection | dB | Not applicable | 50 |
| Antenna | | | |
| Antenna type |  | Slotted waveguide | Horn |
| Antenna placement |  | Ground/Surface | Bottom of aircraft |
| Antenna gain [[2]](#footnote-2) | dBi | Azimuth: 32;  Elevation: 26 | 6 |
| First antenna side-lobe | dBi | At least 17 dB below peak | At least 17 dB below peak |
|  |  |  |  |
| Antenna azimuth beamwidth | degrees | Horizontal: 40;  Vertical: 1.3 | 70 |
| Antenna elevation Vertical beamwidth | degrees | Horizontal: 2; Vertical: 6 | 36 |
| Polarization |  | Vertical | Vertical |
| Antenna scan | degrees | Sector Scan | Fixed |
|  |  |  |  |

Annex 2

# A2-1 Antenna characteristics

Onboard airborne detect and avoid radars Nos. 4 and 5 use antennas with MIMO (Multiple Input Multiple Output) fix panel. Therefore, these characteristics are complemented to obtain the complete radiation pattern for one panel. One panel does not allow to obtain the requested Field of Regard (FoR). The FoR of the radar refers to the area that has to be covered by the radar and is defined by the azimuth and elevation angles in regard to the platform coordinates. To obtain the requested FoR, it is necessary to use several panels. Typical FoR for DAA is ±110°, and is obtained by the use of 3 panels (each one covering 80°.

Typical Field of Regard

A pie chart with a circle and a circle with a circle and a circle with a circle with a circle and a circle with a circle with a circle with a circle with a circle with a circle

Description automatically generated with medium confidence

]

Single Antenna Pattern in azimuth

A graph showing the antenna diagram

Description automatically generated

[Editor’s note: To be completed for elevation pattern by one administration.]

1. The criterion of protection does not include aeronautical safety margin. [↑](#footnote-ref-1)
2. There are two transmit antenna systems one for azimuth and one for elevation. [↑](#footnote-ref-2)