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| **U.S. Radiocommunications Sector**  **Fact Sheet** | |
| **Working Party:** ITU-R WP-5B | **Document No:** USWP5B36-XX |
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| **Document Title:** WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT NEW  RECOMMENDATION ITU-R M.[24.45-24.65\_GHZ\_ARNS]- Characteristics of and protection criteria for radars operating in the radionavigation service in the frequency band 24.45-24.65 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 24.45-24.65 GHz band. This contribution will be an update to the new report found in Annex 1.6 of Document 5B/435-E. | |
| **Abstract:** This contribution is a new recommendation for UAS Detect and Avoid (DAA) systems that operate in the 24.45-24.65 GHz Aeronautical Radionavigation Service allocation. This contribution contains characteristics and protection criteria for UAS DAA radar that can be used both on airborne and ground platforms. | |

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| **Radiocommunication Study Groups** |  |
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| WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT NEW  RECOMMENDATION ITU-R M.[24.45-24.65\_GHZ\_ARNS] | |
| Characteristics of and protection criteria for radars operating in the  radionavigation service in the frequency band 24.45-24.65 GHz | |

Introduction

TBD

Proposal

TBD

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| Annex 1.7 to Working Party 5B Chair’s Report |
| WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT NEW  RECOMMENDATION ITU-R M.[24.45-24.65\_GHZ\_ARNS] |
| Characteristics of and protection criteria for radars operating in the  radionavigation service in the frequency band 24.45-24.65 GHz |

(202X)

**Scope**

This document specifies the characteristics and protection criteria of radars operating in the radionavigation service (RNS) in the frequency band 24.45-24.65 GHz. The technical and operational characteristics should be used in analysing compatibility between radars operating in the radionavigation service and systems in other services.

**Keywords**

24.45-24.65 GHz, radar, characteristics, protection.

**Abbreviations/Glossary**

RNS radionavigation service

DAA Detect and avoid

ESA Electronically scanned array

FMCW Frequency-modulated continuous wave

RCS Radar cross-section

RR Radio Regulations

SNR Signal-to-noise power ratio

UA Unmanned aircraft

UAS Unmanned aircraft system

**Related ITU Recommendations, 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*

*Reports*

[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*

that the technical characteristics of detect and avoid radars operating in the radionavigation service (RNS) are driven by the performance requirement and depend on the frequency band,

*recognizing*

*a)* that the frequency band 24.45-24.65 GHz is allocated on a primary basis to the radionavigation, fixed, mobile except aeronautical mobile, and inter-satellite services in ITU‑R Region 2;

*b)* that the frequency band 24.45-24.65 GHz is allocated on a primary basis to the radionavigation, inter-satellite, fixed, and mobile services in ITU-R Region 3;

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

*d)* that some interference suppression techniques between radars are contained in Recommendation ITU-R M.1372 “Efficient use of the radio spectrum by radar stations in the radiodetermination service”;

*e)* that the inter-satellite service operating in the frequency band 24.45-24.65 GHz shall not claim protection from harmful interference from airport surface detection equipment stations of the radionavigation service according to RR No. **5.533**;

*f)* that the frequency band 24.45-24.65 GHz is not allocated to radionavigation service in Region 1;

*g)* that this frequency band is harmonised for IMT in large number of countries in Region 1;

*h)* that based on *recognizing* *f)* and *g)* it is not possible to have a worldwide airborne DAA application in the frequency band 24.45-24.65 GHz in particular in Region 1;

*i)* that this frequency band is used for Airport Surface Detection Equipment Radar in some countries in Region 3,

*recommends*

1 that the technical and operational characteristics of detect and avoid radars operating in the radionavigation service described in the Annex should be considered representative of those operating in the frequency band 24.45-24.65 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 leve,l (*I*/*N)* of −6 dB[[1]](#footnote-1), should be considered to protect the detect and avoid safety-of-life radars operating in the 24.45-24.65 GHz band, and that this represents the aggregate protection level if multiple interferers are present.

**Annex  
  
Technical and operational characteristics of radars operating in the  
radionavigation service in the  
frequency band 24.45-24.65 GHz**

**A-1 Introduction**

RNS system operates in Regions 2 and 3 on a primary basis in the frequency band 24.45‑24.65 GHz. This Annex presents the technical and operational characteristics of representative RNS radars operating in this frequency band.

These RNS 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. These radars are used for collision avoidance on-board UA and can be used as a part of the integration of unmanned aircraft system (UAS).

**A-2 Characteristics of radionavigation detect and avoid radar**

The technical parameters are provided in Table A-1.

TABLE A-1

**Technical parameters of detect and avoid radar**

| **Parameter** | **Units** | **Radar 1** (Note 1) | **Radar 2** (Note 1) | **Radar 3** (Note 1) | **Radar 4** |
| --- | --- | --- | --- | --- | --- |
| Platform |  | Airborne/Ground | Airborne/Ground | Airborne/Ground | Ground |
| Platform height | m | Up to 3 000 / 20 000 for airborne DAA  Up to [100] for ground-based DAA | Up to 3 000 / 20 000 for airborne DAA  Up to [100] for ground-based DAA | Up to 3 000 / 20 000 for airborne DAA  Up to [100] for ground-based DAA | N/A |
| Radar type |  | FMCW | FMCW | FMCW | FMCW |
| Operating range [(Note 2)] | km | 6 | 6 | 3.5 | 3.5 |
| Maximum number of DAA systems within the same operating area |  | 3 to 8 | 3 to 10 | 3 to 10 | 1 |
| Ground relative speed  [(Note 2)] | m/s | 120 | 120 | 40 (for typical waveform) | N/A |
| Target speeds (max) | m/s | 200 | 200 | 94 (for typical waveform) | N/A |
| **Transmitter** | | | | |  |
| Frequency range  [(Note 3)] | GHz | 24.45-24.65 | 24.45-24.65 | 24.45-24.65 | 24.45-24.65 |
| Channel selection method between radars [(Note 4)] |  | Software selectable | Software selectable | Software selectable | N/A |
| RF bandwidth | MHz | 45 | 10 to 50 [(Note 4)] | 20 or 40 | TBD |
| Pulse width | μs | 200 | 50 to 200 (Note 5) | 33 (chirp time) | TBD |
| Pulse rise and fall times | μs | 1 | 1 | 0.1 | TBD |
| RF emission bandwidth at   −3 dBc  −20 dBc  −40 dBc | MHz | 47.1 55 75 | 47.1 55 75 | 37 40.75 42.9 | TBD |
| Pulse repetition frequency | Hz | 47 000 | 2 000 to 10 000 | 303 000 | TBD |
| Pulse repetition interval | μs | 5 (Note 6) | 5 (Note 6) | 33 | TBD |
| Average transmitter power [(conducted) during emission time; Editor’s Note: Clarify in future version what exactly is meant here. Pulse envelop power?] | W | 2 | 3.2 | 0.8 | TBD |
| Out-of-band emission characteristics [Editor’s note: to harmonize with RF emission bandwidth at   −3 dBc] | dBc [Editor’s Note: Harmonize the units for this row] | Measured at 84 dBuV/m at 3 m through 4th harmonics | Measured at 84 dBuV/m at 3 m through 4th harmonics | 70 | TBD |
| Spurious emission characteristics  (conducted) | [dBc/dB/dBm in 1 MHz BW] Editor’s Note: Review for next WP 5B meeting to harmonize units | 65 | 65 | 84 | TBD |
| **Receiver** | | | | |  |
| Receiver IF bandwidth  −3 dB  −20 dB  −60 dB | MHz | 9.8 20  60 | 9.8 20  60 | 48.5 65  78 | TBD |
| Sensitivity (MDS) (at RX input. SNR = 12 dB) | dBm | −131 | −131 | −141 | TBD |
| Receiver noise figure | dB | 6 | 6 | 6.5 | TBD |
| Calculated Rx noise power (Note 7) | dBW | −131 | −134 | −121 | TBD |
| Saturation level | dBm | −40 | −40 | −50 | TBD |
| **Antenna** | | | | |  |
| Antenna type |  | ESA (Note 8) | ESA (Note 8) | Phased array (Note 8) | Phased array, sector |
| Antenna placement (Note 1) |  | Fixed (internally sealed package) Pointing to be indicated | Fixed (internally sealed package) Pointing to be indicated | Front panel, integrated in the module (internally sealed package) | N/A |
| Maximum antenna gain | dBi | 21 | 21 | 17 | TBD |
| Antenna pattern *[Editor’s note: the antenna pattern is expected because the following information would support its characterization but not replace it.]* | N/A | TBD | TBD | TBD | TBD |
| Antenna pointing |  | [XX for airborne DAA  XX° elevation for ground-based DAA] | [XX for airborne DAA  XX° elevation for ground-based DAA] | [XX for airborne DAA  XX° elevation for ground-based DAA] | N/A |
| First antenna sidelobe | dBi | 16  Editor’s note: This is only 5 dB below the max antenna gain. | 16  Editor’s note: This is only 5 dB below the max antenna gain. | 5 | TBD |
| Horizontal beamwidth [(2-way at 0,0)] | degrees | 12 degrees one-way | 12 degrees one-way | 28 | TBD |
| Vertical beamwidth [(2-way at 0,0)] | degrees | 12 degrees one-way | 12 degrees one-way | 28 | TBD |
| Polarization |  | Horizontal | Horizontal | Vertical | Vertical |
| Field of Regard | degrees | Airborne DAA:  −40/40 el  −60/60 az  Ground based DAA:  TBC | Airborne DAA:  −40/40 el  −60/60 az  Ground based DAA:  TBC | ±118  Editor’s note: Confirm if it applies in azimuth and if it applies to both airborne and ground based DAA. Specify the elevation field of regards. | TBD |
| Horizontal antenna scan (from boresight) | degrees | ±60 | ±60 | ±45  Editor’s note: Clarify how this value relates to the line above. | TBD |
| Vertical antenna scan (from boresight) | degrees | ±40 | ±40 | ±45 | TBD |
| 1 [These DAA radars can also be deployed on airborne or on ground, noting that this band, due to its non-worldwide allocation, is to be preferred for ground-based DAA or for local on-board DAA operations.]  [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 Utilized bandwidth - Inclusive of frequency-channel guard-bands.]  4 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.  [5 Waveform is software-defined on a CPI-by-CPI basis, and optimized for targets, and spectral environments.]  6 The radar is dynamic/cognitive radar and the PRI/PRR can be changed dynamically based on a number of characteristics (terrain, target, etc.). The PRR/PRI can be higher with future software revisions for specific mission sets.  7 Compressed bandwidth before processing gain.  8 High T/R ESA RF beamforming on both transmit and receive. | | | | | |

1. The criterion of protection does not include aeronautical safety margin. [↑](#footnote-ref-1)