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| U.S. Radiocommunications Sector  Fact Sheet | |
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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 aeronautical radionavigation service in the frequency band 24.45-24.65 GHz | |
| **Author(s)/Contributors(s):**  Don Nellis  Federal Aviation Administration  800 Independence Ave., S.W.  Washington, DC 20591  Mohammed Rahman  Federal Aviation Administration  800 Independence Ave., S.W.  Washington, DC 20591  Michael Neale  ACES Corporation for the FAA | Phone: (202) 267-9779  e-mail: Donald.Nellis@faa.gov  Phone: (202) 267-6573  e-mail: Mohammed.Rahman@faa.gov  Phone: (858) 705-8978  e-mail: Michael.Neale@ACES-INC.COM |
| **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. | |
| **Abstract:** This contribution will begin the process of developing a new recommendation containing characteristics of and protection criteria for systems that operate in the 24.45-24.65 GHz Aeronautical Radionavigation Service allocation including UAS DAA systems. | |

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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\_DAA\_RADAR] | |
| **Characteristics of and protection criteria for radars operating in the  aeronautical radionavigation service in the frequency  band 24.45-24.65 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 radionavigation service in the frequency band 24.45-24.65 GHz in Regions 2 and 3. 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**

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\* This Recommendation should be brought to the attention of the International Civil Aviation Organization (ICAO).

ATTACHMENT

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   
aeronautical radionavigation service in the frequency   
band 24.45-24.65 GHz

(202X)

Scope

This Recommendation specifies the characteristics and protection criteria of radars operating in the aeronautical radionavigation service (ARNS) 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 aeronautical radionavigation service and systems in other services.

Keywords

24.45-24.65 GHz, radar, characteristics, protection.

Abbreviations/Glossary

ARNS Aeronautical radionavigation service

CDMA Code-Division Multiple Access

DAA Detect and Avoid

e.i.r.p Effective Isotropically Radiated Power

FDMA Frequency Division Multiple Access

FMCW Frequency-Modulated Continuous Wave

GBSS Ground Based Surveillance System

LFM Linear Frequency Modulation

MESA Multi-Role Electronically Scanned Array

PSD Power Spectral Density

TDMA Time-Division Multiple Access

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 24.45-24.65 GHz is allocated on a primary basis to the radionavigation (including aeronautical radionavigation), fixed, 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 (including aeronautical radionavigation), inter-satellite, fixed, and mobile services in ITU-R Region 3;

*c)* that the inter-satellite service operating in the frequency band 24.45-24.65 GHz shall not claim protection from harmful interference from airport surfacedetection equipment stations of the radionavigation service,

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 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 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 24.45-24.65 GHz

# 1 Introduction

ARNS system operates worldwide on a primary basis in the frequency band 24.45-24.65 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-ccoperative 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

Representative Technical parameters of Detect and Avoid radar

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | Radar 1 | Radar 2 |
| Platform |  | Airborne / Ground | Airborne / Ground |
| Platform height | km | Up to 20 (Air)  0 (Ground) | Up to 20(Air)  0 (Ground) |
| Spectral usage |  | Air-to-air and Ground-to-air aeronautical radionavigation DAA radar | Ground-to-air and Ground-to-air aeronautical radionavigation DAA radar |
| Radar type |  | FMCW | FMCW |
| Range class |  | Short range | Medium range |
| Operating range | km | 3 | 8 |
| Maximum number of drones within the same operating area |  | 3 (Air)  8 (Ground) | 3 (Air)  10 (Ground) |
| Ground speed | km/h | <430 | <430 |
| Target speeds (max) | m/s | <200 | <200 |
| Frequency tuning range  (Note 1) | GHz | 24.45-24.65 | 24.45-24.65 |
| Channelization methods |  | FDMA: 3ch 45MHz  CDMA: 4ch  TDMA: 4ch  LFM-dir: up/down (gnd/air) | FDMA: 3 to 6ch  CDMA: 4ch  TDMA (gnd only): 4ch  LFM-dir: up/down (gnd/air) |
| Channel selection method between radars  (Note 2) |  | SW selectable | SW selectable |
| Emission type |  | FXN | FXN |
| Radar Modulation |  | LFM | LFM |
| Modulation bandwidth | MHz | 45 | 10 to 50 (Note 3) |
| Pulse width | μs | 200 | 50 to 200  (Note 3) |
| Pulse rise and fall times | μs | < 1 | < 1 |
| RF emission bandwidth at  -3 dBc  -20 dBc  -40 dBc | MHz | <48  <54  <60 | 110% BWchirp 120% BWchirp 130% BWchirp |
| Pulse repetition frequency | kHz | 4.7 | 2 to 10 |
| Average transmitter power | W | 2 | 12 |
| Out-of-band emission characteristics | dBc | < -75  (through 3rd harmonic) | < -75  (through 3rd harmonic) |
| **Parameter** | **Units** | **Radar 1** | **Radar 2** |
| Spurious emission characteristics | dBuV/m in 1MHz BW | < 83 | < 83 |
| Receiver IF bandwidth  -3 dB  -20 dB  -60 dB | MHz | < 10  < 20  < 70 | <10  < 30  < 40 |
| Sensitivity (MDS)  (at RX input. SNR=12dB) | dBm | -119 dBm | -122 dBm |
| Receiver noise figure | dB | 6 | 3 |
| Calculated Rx noise power (Note 4) | dBW | -131 dBm | -134 dBm |
| Saturation level | dBm | -40 | -40 |
| Antenna type |  | ESA (Note 5) | ESA  (Note 5) |
| Antenna placement |  | Fixed  (internally sealed package) | Fixed  (internally sealed package) |
| Antenna gain | dBi | 21 | 27 |
| First antenna sidelobe | dBi | < -16 | < -16 |
| Horizontal beamwidth (2-way at 0,0) | degrees | 2 | 2 |
| Vertical beamwidth (2-way at 0,0) | degrees | 6 | 2 |
| Polarization |  | Horizontal | Horizontal |
| Horizontal antenna scan  (from boresight) | degrees | ±60 | ±60 |
| Vertical antenna scan  (from boresight) | degrees | ±40 | ±40 |
| Protection criteria  [*I/N* or false detection ratio] | dB | [TBD] | [TBD] |

Notes:

1. Utilized bandwidth - Inclusive of frequency-channel guard-bands.
2. Channel selection is purely SW-defined and can be on-the-fly dynamic. Some settings may allow radar to self-configure based on detected spectrum-conflict.
3. Waveform is software-defined on a CPI-by-CPI basis, and optimized for targets, and spectral environments.
4. Compressed bandwidth before processing gain.
5. High T/R ESA RF beamforming on both transmit and receive.

# 3 Protection criteria

***Editor’s note:*** *Further discussion will be needed.*