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| **Radiocommunication Study Groups** |  |
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| Annex 6 to Working Party 5B Chairman’s Report | |
| WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT NEW REcommendation ITU-R M.[RAD 92-100 GHz] | |
| Technical and operational characteristics of radiolocation systems  operating in the frequency range 92-100 GHz and radionavigation systems operating in the frequency range 95-100 GHz | |

Scope

This Recommendation contains the technical and operational characteristics of the radiolocation and radionavigation systems operating in the frequency range 92-100 GHz and 95-100 GHz, respectively. The parameters are intended to be used as a guideline in analyzing compatibility between radars operating in the radiolocation service or in the radionavigation service with systems in other services.

Keywords

Radar, characteristics

Abbreviations/Glossary

FOD Foreign object debris

Related ITU Recommendations and Reports

Recommendation

[ITU‑R M.1461](https://www.itu.int/rec/R-REC-M.1461/en) *Procedures for determining the potential for interference between radars operating in the radiodetermination service and systems in other services*

The ITU Radiocommunication Assembly,

considering

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

*b)* that the technical characteristics of radars operating in the radiolocation and radionavigation services are determined by the mission of the system and vary widely even within a band;

*c)* that representative technical and operational characteristics of radars operating in the radiolocation and radionavigation services are required to determine, if necessary, the feasibility of introducing new types of systems into frequency bands allocated to the radiolocation and radionavigation services,

recognizing

*a)* that No. **5.554** of the RR states that in the band 95-100 GHz, satellite links connecting land stations at specified fixed points are also authorized when used in conjunction with the mobile-satellite service or the radionavigation-satellite service;

*b)* that the frequency band 94-94.1 GHz is allocated to the earth exploration satellite (active) service, space research (active) service, radiolocation service on a primary basis and radio astronomy on a secondary basis;

*c)* that the use of the band 94-94.1 GHz by the Earth exploration-satellite (active) and space research (active) services is limited to spaceborne cloud radars;

*d)* that the frequency band 94.1-95 GHz is allocated to the fixed service, mobile service, radio astronomy, radiolocation services on a primary basis;

*e)* that the frequency band 95-100 GHz is allocated to the fixed service, mobile service, radio astronomy, radiolocation, radionavigation and radionavigation satellite services on a primary basis,

noting

that Recommendation [ITU‑R M.1461](http://www.itu.int/rec/R-REC-M.1641/en) is also used as a guideline in analysing the compatibility between radars and other services to which the frequency band is allocated,

recommends

1 that the technical and operational characteristics and protection criteria of the radiolocation and radionavigation systems described in the Annex should be considered representative of those operating in the frequency range 92-100 GHz and 95-100 GHz, respectively;

2 that these characteristics should be used when conducting sharing studies.

Annex

Technical and operational characteristics of radiolocation systems   
operating in the frequency range 92-100 GHz and radionavigation  
systems operating in the frequency range 95-100 GHz

# 1 Introduction

Different types of radars operate in the frequency range 92-100 GHz. Their operational and technical characteristics are described in the following paragraphs.

# 2 Characteristics of radars in the 92-100 GHz range

Representative characteristics of radiolocation systems in the range 92-100 GHz are provided in the following sections. The information presented in this Annex is sufficient for general calculations to assess the compatibility between these radars and other systems.

## 2.1 Ground weather radars at 94-100 GHz

The frequency range 94-100 GHz provides appropriate characteristics that can be used for dedicated study of clouds and fog. These radars use a low peak power transmitter and frequency modulated continuous wave technology. These radars, in vertical operation, provide access to the vertical distribution of clouds and the sedimentation velocity of hydrometeors and measure the energy backscattered by these hydrometeors. This energy can be related to the amount of water contained in the cloud (liquid and ice). The Doppler capability of these radars offers the possibility to measure the speed of hydrometeors along the line of sight.

A large variety of meteorological conditions and cloud types can then be observed, including low clouds, fog, cirrus, and liquid precipitation. For example a set up based on a vertical resolution of 25 m, an integration time sets to 3 s (with a maximum range of 12 km), and a Nyquist velocity of 5 m s−1, provides a capability of continuously detection of all types of clouds with its sensitivity of about −44 dBz at 1 km for an uninterrupted periods of time.

Table 1

Characteristics of radars in the 94-100 GHz range

| Parameter | Units | Radar A |
| --- | --- | --- |
| Application |  | Weather (heavy rainfall detection) |
| Deployment area |  | Worldwide, fixed site |
| Tuning type; range | GHz | 94-100 |
| Transmitter type | – | Solid state |
| Tx power into antenna (peak) | W | 0.5-1 |
| Polarization |  | Linear |
| Pulse duration | ms | 0.04 – 0.16 |
| frequency modulation |  | FM CW |
| Pulse repetition period | µs | 80-160 |
| Antenna type |  | Parabolic |
| Radar height relative to the ground | m | 1 |
| Antenna gain | dBi | 54 |
| Antenna diameter | m | 0.6 |
| Antenna beamwidth in azimuth | degrees | 0.4 |
| Antenna beamwidth in elevation | degrees | 0.4 |
| Antenna peak side-lobe (SL) levels | dBi | 24 |
| Antenna pattern type |  | Recommendation ITU-R M.1851, COS2 Pattern? |
| Receiver noise floor. See M.1461 below eq. (4) | dBm | −114 (Value does not match either 1.5 or 24 MHz bandwidth) |
| receiver noise figure | dB | 7 |
| RF emission bandwidth | MHz | up to 24 |
| Receiver IF 3 dB bandwidth | MHz | 1.5-24 |
| *I/N* protection criteria | dB | (–6 or –10?) |

## 2.2 Airport Foreign object debris detection system operating in the frequency range 92‑100 GHz

Foreign object debris (FOD) detection system operating in the frequency range 92-100 GHz can provide such performance as high detection sensitivity, short detection response time, sufficient coverage of surveillance runway area and high location accuracy for safety airport operation. Table 2 summarizes the technical and operational characteristics of FOD detection system operating in the frequency range 92-100 GHz.

Foreign Object Debris (FOD) is any object located in an inappropriate location in the airport environment that has the capacity to injure airport or airline personnel and damage aircraft. The presence of FOD on airport runways, taxiways, aprons and ramps poses a significant threat to the safety of air travel. FOD has the potential to damage aircraft during critical phases of flight, which can lead to catastrophic loss of life and airframe, and increased maintenance and operating costs. FOD hazards can be reduced, however, using FOD detection equipment.

FOD Hazards can severely injure airport or airline personnel or damage equipment. Types of potential damage include: cutting aircraft tires; being ingested into engines; or becoming lodged in mechanisms affecting flight operations. Personnel injuries can occur when jet blast propels FOD through the airport environment at high velocities.

Dark-coloured items made up nearly 50% of the FOD collected. Common FOD dimensions can be 3 cm by 3 cm or smaller. Typical FOD includes the following:

– aircraft and engine fasteners (nuts, bolts, washers, safety wire, etc.);

– aircraft parts (fuel caps, landing gear fragments, oil sticks, metal sheets, trapdoors, and tire fragments);

– mechanics' tools;

– catering supplies;

– flight line items (nails, personnel badges, pens, pencils, luggage tags, soda cans, etc.);

– apron items (paper and plastic debris from catering and freight pallets, luggage parts, and debris from ramp equipment);

– runway and taxiway materials (concrete and asphalt chunks, rubber joint materials, and paint chips);

– construction debris (pieces of wood, stones, fasteners and miscellaneous metal objects);

– plastic and/or polyethylene materials;

– natural materials (plant fragments and wildlife); and

– contaminants from winter conditions (snow, ice).

Reference USA FAA Advisory Circular (AC) 150/5220-24, “Airport Foreign Object Debris (FOD) Detection Equipment” 30 September 2009.

Table 2

Technical and operational characteristics of foreign object debris   
detection system operating in the frequency range 92-100 GHz

| Parameters | Units | Values |
| --- | --- | --- |
| Frequency range | GHz | 92….100 |
| Channel bandwidth | GHz | 0.58….7.98 |
| Channel plan |  | See Figure 1 |
| Transmit peak power | mW | 200 |
| Sweep frequency (FM-CW) | kHz | 1.250 |
| Antenna type |  | Cassegrain |
| Antenna gain | dBi | 42 |
| Antenna pattern type |  | Recommendation ITU-R M.1851 |
| Antenna height | m | 6….8 |
| Full width at half maximum antenna gain (3 dB beamwidth) | degrees | Elevation: 1.0, Azimuth: 1.0 |
| Antenna rotation speed | rpm | 15 |
| Detection distance | m | 5200 |
| Radiated rotation angle in azimuth | degrees | ±60 |
| Radar cross section specification | dB/m2 | −20 |
| Range resolution | cm | 3…..50 |
| Emission bandwidth (−3 dB) | MHz | 1 |
| Emission bandwidth (−20 dB) | MHz | 3.5 |
| Adjacent channel leakage ration | dBc | < −70 |
| Receiver noise figure | dB | 10 |
| *I/N* protection criteria | dB | [−6 or −10] |

FIGURE 1

Channel plan for foreign object debris detection system operating in the frequency range 92-100 GHz

