

RECOMMENDATION ITU-R M.1644

Technical and operational characteristics, and criteria for protecting the mission of radars in the radiolocation and radionavigation service operating in the frequency band 13.75-14 GHz

(Question ITU-R 226/8)

(2003)

Summary

This Recommendation provides the technical and operational characteristics, and criteria for protecting the radiolocation and radionavigation radars operating in the 13.75-14 GHz band. It contains a detailed description of the predominant shipborne radiolocation radar in the band, plus a tabular set of characteristics of all the known shipborne, airborne and ground-based radars operating in the band.

The ITU Radiocommunication Assembly,

considering

- a) that the antenna, signal propagation, target detection, and large necessary bandwidth characteristics of radars needed to achieve their functions are optimum in certain frequency bands;
- b) that the technical characteristics and protection criteria of radiolocation and radionavigation radars are determined by the mission of the system and vary widely even within a band;
- c) that considerable radiolocation and radionavigation spectrum allocations (amounting to about 1 GHz) have been removed or downgraded since WARC-79;
- d) that some ITU-R technical groups are considering the potential for the introduction of new types of services (e.g. fixed satellite, wireless access, and high-density fixed and mobile) in bands between 420 MHz and 34 GHz used by radionavigation and radiolocation radars;
- e) that representative technical and operational characteristics of radiolocation and radionavigation radars are required to determine the feasibility of introducing new types of systems into frequency bands in which the radars are operated;
- f) that criteria for protection of the radars' missions are also needed for that same purpose;
- g) that some radiolocation and radionavigation radars operate in both the 13.75-14 GHz band and the 13.4-13.75 GHz band;
- h) that radiolocation and radionavigation radars operate in both airborne and shipborne platforms, by many administrations in all regions of the globe, and on land by at least one administration,

recommends

- 1 that the technical and operational characteristics of the radars described in Annex 1 be considered representative of radars operating in the frequency band 13.75-14 GHz;
- 2 that the appropriate criteria for protecting the operational performance of those radars presented in Annex 1;
- 3 that those criteria be used in analysing compatibility between those radars and systems in other services;
- 4 that in the presence of any modulated continuous wave (CW) interfering signals with most or all of its 3 dB emission bandwidth spanned by the radar receiver passband in the main beam direction, the ratio of interfering signal power to radar receiver noise power level, I/N , of -6 dB be used as the interference protection criteria for the radars described in Annex 1, consistent with the guidance contained in Recommendation ITU-R M.1461.

This protection criterion represents the net protection level if multiple interferers are present. This threshold value is to be used in conjunction with the overall mission-protection criteria presented in Annex 1.

Annex 1

Characteristics of radiolocation and radionavigation radars and criteria for protection of their mission

1 Introduction

The band 13.75-14 GHz is allocated on a primary basis to the radiolocation service, the FSS (Earth-to-space), and certain functions of the space research service. It is also allocated for the radionavigation service by some administrations. The standard frequency and time signal-satellite service (Earth-to-space) operates in this band on a secondary basis.

2 Mission

The radars described in § 2 through 5 of this Annex are used worldwide, primarily aboard ships operated by many administrations. They operate in sea and coastal areas, and there are a few land-based sites. They are used to detect and track discrete approaching airborne and surface objects (conventionally referred to in radar literature as targets). Many ships are equipped with several of these radars, and radars of this type aboard one ship cannot serve the needs of other ships even if they are nearby. Since some of the targets of interest are airborne at very low altitude, the 13.75-14 GHz band offers an ideal compromise between multipath phenomena and atmospheric attenuation for performance of this mission. Similarly, many airborne and land-based radars perform the same function as the shipborne radar systems.

3 Technical characteristics

The radiolocation system characteristics contained herein represent the predominant type of shipborne radar operating in the 13.75-14 GHz band. Table 4 in Appendix 1 to this Annex provide characteristics for other airborne, shipborne, and land-based radar systems operating in the band 13.75-14 GHz. The characteristics in § 2 through 5 of this Annex should be used in studies of sharing with these shipborne radars, and the characteristics in Appendix 1 should be used with the other types of radars.

3.1.1 Transmitter power/radiated power

The transmitter is a klystron with peak output power of 30 kW (45 dBW). Search loss from transmitter to antenna is –5 dB; track loss from transmitter to antenna is –4 dB.

3.1.2 Search

Search peak equivalent isotropically radiated power (dBW) = transmitter peak power (dBW) – transmission line loss (dB) + antenna gain (dBi):

Beam 1 peak e.i.r.p. = $45 - 5 + 31.5 = 71.5$ dBW;

Average e.i.r.p. = 57.2 to 54.9 dBW¹;

Beams 2, 3, and 4 peak e.i.r.p. = $45 - 5 + 28.5 = 68.5$ dBW;

Average e.i.r.p. = 54.2 to 51.9 dBW¹.

3.1.2.1 Search waveforms

The search system uses a coherent transmitter/receiver for digital moving target indicator processing.

3.1.2.1.1 Low pulse repetition frequency mode

Pulse width (PW): 2.2 μ s phase coded with 0.2 μ s segments

Pulse repetition interval (PRI): minimum = 60 μ s; maximum = 100 μ s

Duty factor: maximum = 3.7% (–14.3 dB); minimum = 2.2% (–16.6 dB).

3.1.2.1.2 High pulse repetition frequency (clutter) mode

Pulse width: 0.2 μ s

Pulse repetition interval: between 10 and 14 μ s.

3.1.3 Track

Track peak e.i.r.p. (dBW) = transmitter peak power (dBW) – transmission line loss (dB) + antenna gain (dBi):

Track peak e.i.r.p. = $45 - 4 + 38.5 = 79.5$ dBW;

Average acquisition e.i.r.p. = 62.5 to 61.0 dBW¹;

Average track e.i.r.p. = 59.5 to 58.0 dBW¹.

¹ The average powers given here are for periods of time equal to a fraction of a second, and should not be compared to the e.i.r.p. limit in No. 5.502 of the Radio Regulations, which applies for a period of time equal to one second.

3.1.3.1 Track waveform

The track system uses a coherent transmitter/receiver for pulse-Doppler processing.

Pulse width: 0.2 μ s in acquisition; 0.1 μ s in track

Pulse repetition interval: between 10 and 14 μ s

Duty factor: acquisition 2% (–17 dB) to 1.4% (–18.5 dB);
track 1% (–20 dB) to 0.7% (–21.5 dB).

3.2 Radar receiver noise level and losses

N = Radar receiver thermal noise = –134 dBW in a 10 MHz bandwidth.

This is the noise level of the terrestrial environment in a 10 MHz reference bandwidth without any receiver-added noise.

NF = Radar noise figure = 5 dB.

Receiver noise level = –129 dBW (10 MHz bandwidth).

This is the level with the receiver-added noise included.

L_{RF} = RF transmission line loss between the radar antenna and preamplifier = 2 dB.

The overall receiving-system noise level referred to the antenna port and expressed in a 10 MHz reference bandwidth is therefore:

$$-129 + 2 = -127 \text{ dBW}$$

3.3 Antenna characteristics

Each of these radars contains two separate antenna assemblies. One set of antennas is used for the search function, and another antenna is used for the acquisition and track functions.

3.3.1 Search antennas

Configuration 1 elevation coverage is accomplished using one 10° antenna centred at 4.5° (1F) and one 20° antenna (4F) centred at 60°, both facing forward, and two 20° antennas centred at 20° (2B) and 40° (3B), both facing backward. Figure 1 presents the composite elevation coverage pattern with all antennas superimposed. Table 1 lists parameters of the search antennas.

