International Telecommunication Union

ITU-R

Radiocommunication Sector of ITU

**Recommendation ITU-R M.1466-1**
**(01/2017)**

# Characteristics of and protection criteria for radars operating in the radionavigation service in the frequency band 31.8-33.4 GHz

**M Series**

**Mobile, radiodetermination, amateur and related satellite services**

## Foreword

The role of the Radiocommunication Sector is to ensure the rational, equitable, efficient and economical use of the radio-frequency spectrum by all radiocommunication services, including satellite services, and carry out studies without limit of frequency range on the basis of which Recommendations are adopted.

The regulatory and policy functions of the Radiocommunication Sector are performed by World and Regional Radiocommunication Conferences and Radiocommunication Assemblies supported by Study Groups.

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### Series of ITU-R Recommendations

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| Series | Title |
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| **BS** | Broadcasting service (sound) |
| **BT** | Broadcasting service (television) |
| **F** | Fixed service |
| **M** | **Mobile, radiodetermination, amateur and related satellite services** |
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| **RA** | Radio astronomy |
| **RS** | Remote sensing systems |
| **S** | Fixed-satellite service |
| **SA** | Space applications and meteorology |
| **SF** | Frequency sharing and coordination between fixed-satellite and fixed service systems |
| **SM** | Spectrum management |
| **SNG** | Satellite news gathering |
| **TF** | Time signals and frequency standards emissions |
| **V** | Vocabulary and related subjects |

***Note***: *This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.*

*Electronic Publication*
Geneva, 2017

RECOMMENDATION ITU-R M.1466-1*

# Characteristics of and protection criteria for radars operating in the radionavigation service in the frequency band 31.8-33.4 GHz

(2000-2017)

**Scope**

This Recommendation specifies the characteristics of and protection criteria for radars operating in the radionavigation service in the frequency band 31.8-33.4 GHz. These technical and operational characteristics are to be used as a guideline in analyzing compatibility between radars operating in the radiodetermination service with systems in other services.

**Keywords**

Radionavigation, aircraft

**Abbreviations/Glossary**

| | |
|---|---|
| dBi | Antenna gain relative to an isotropic radiator |
| dBm | Power expressed in decibels relative to one milliwatt |
| dBW | Power expressed in decibels relative to one watt |
| IF | Intermediate frequency |
| *I*/*N* | Interference to receiver noise ratio |
| PPS | Pulses per second |
| PRF | Pulse repetition frequency |
| RF | Radio Frequency |

**Related ITU-R Recommendations**

1 Recommendation ITU-R M.1461 – Procedures for determining the potential for interference between radars operating in the radiodetermination service and systems in other services

2 Recommendation ITU-R M.1851 – Mathematical models for radiodetermination radar systems antenna patterns for use in interference analyses

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 radiodetermination service are determined by the mission of the system and vary widely even within a band;

*c)* that the radionavigation service is a safety service as specified by RR No. 4.10 and harmful interference to it cannot be accepted;

* Radiocommunication Study Group 5 made editorial amendments to this Recommendation in 2008 in accordance with Resolution ITU-R 44.

*d)* that considerable radiolocation and radionavigation spectrum allocations (amounting to about 1 GHz) have been removed or downgraded since WARC-79;

*e)* that some ITU-R technical groups are considering the potential for the introduction of new types of systems (e.g. fixed wireless access and high density fixed and mobile systems) or services in bands between 420 MHz and 34 GHz used by radars in the radiodetermination service;

*f)* that representative technical and operational characteristics of systems operating in bands allocated to the radiodetermination service are required to determine the feasibility of introducing new types of systems;

*g)* that procedures and methodologies are needed to analyse compatibility between radars operating in the radiodetermination service and systems in other services;

*h)* that WRC-97 requested that the ITU-R conduct studies to determine what criteria would be necessary for sharing between stations in the fixed service and stations in the other services to which the frequency band 31.8-33.4 GHz is allocated;

*j)* that the frequency band 31.8-33.4 GHz is allocated on a primary basis to the fixed and radionavigation services and that portions of the band are allocated on a primary basis to the space research (deep space) and inter-satellite services,

*recommends*

**1** that the technical and operational characteristics of the radars operating in the radionavigation service described in Annex 1 should be considered representative of those operating in the frequency band 31.8-33.4 GHz;

**2** that Recommendation ITU-R M.1461 should be used as a guideline in analysing compatibility between radars operating in the radiodetermination service with systems in other services;

**3** 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 radionavigation radars, and that this represents the net protection level if multiple interferers are present.

# Annex 1

# Technical and operational characteristics of radars operating in the radionavigation service in the frequency band 31.8-33.4 GHz

## 1 Introduction

The radionavigation service operates worldwide on a primary basis in the frequency band 31.8-33.4 GHz. This Annex presents the technical and operational characteristics of representative radars operating in the radionavigation service in this frequency band.

## 2 Technical characteristics of radionavigation systems in the frequency band 31.8-33.4 GHz

The technical parameters of three radionavigation radars operating in the frequency band 31.8-33.4 GHz are presented in Table 1 and Table 2. All systems are operated worldwide aboard

aircraft. The radars are used for ground mapping, weather avoidance, to calibrate aircraft on-board navigation systems for accurate aerial delivery in adverse weather conditions and to provide data to pilots in order to reduce the decision height during landing phases in adverse weather conditions.

TABLE 1

**Radionavigation radar characteristics in the frequency band 31.8-33.4 GHz (Radars Nos 1 and 2)**

| Parameter | Units | Radar No. 1 | Radar No. 2 |
|---|---|---|---|
| Tuning type | | Fixed frequency<br>Tunes continuously across 31.8-33.4 GHz | Fixed frequency or frequency hopping<br>Operates in either mode on one of 9 discrete channels spaced 100 MHz apart (32.2-33 GHz) |
| Emission type | | Unmodulated pulses | |
| RF emission bandwidth | MHz | 37 | 17 (instantaneous)<br>117 (hopping) |
| Pulse duration | μs | 0.2 | |
| Pulse repetition frequency | pps | 2 000 | 1 600 |
| Peak transmitter power | kW | 60 | 39 |
| Receiver IF bandwidth (−20 dB) | MHz | 40 | 17 |
| Receiver noise figure | dB | 11 | |
| Antenna type | | Parabolic reflector | |
| Antenna main beam gain | dBi | 44 | 41.1 |
| Antenna scan | | Elevation: −30° to +10°, manual<br>azimuth: 360° at 7, 12, or 21 rpm | Elevation: −30° to +10°, manual<br>azimuth: 360° at 12 or 45 rpm |

TABLE 2

**Radionavigation radar characteristics in the frequency band 31.8-33.4 GHz (Radars No. 3)**

| Parameter | Units | Radar No. 3 |
|---|---|---|
| Type | | Aircraft |
| Altitude | m | Maximum: from 300 to ground<br>Nominal: from 150 to ground |
| Center frequency | GHz | Adjustable from 31.8 to 33.4 GHz |
| Modulation | | FMCW |
| Chirp RF emission bandwidth | MHz | From 20 to 500<br>Nominal: 200 |
| Peak transmitter power | W | 5-20<br>Nominal 5 |
| Pulse repetition frequency | pps | 500 (FM cycle repetition frequency) |
| Receiver IF bandwidth (−3 dB) | MHz | 60 |
| Receiver noise figure | dB | 6 |

TABLE 2 (*continued*)

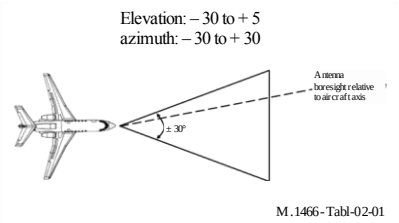
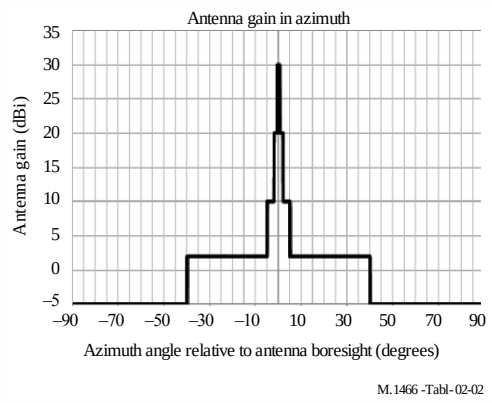
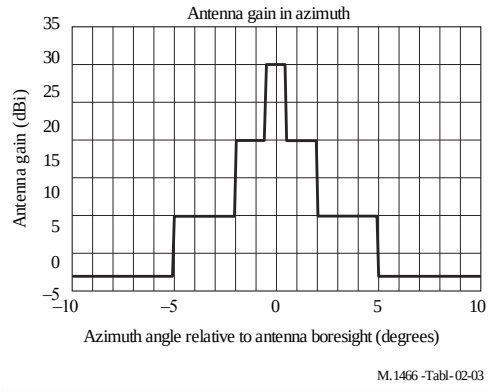
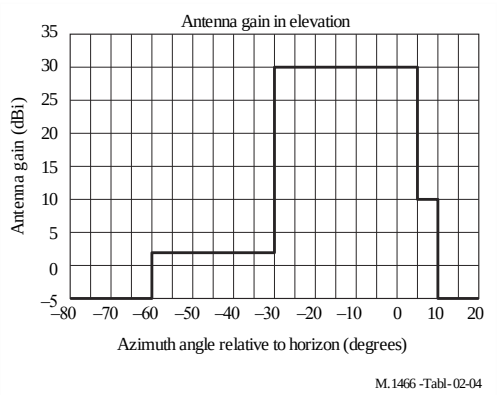
| Parameter | Units | Radar No. 3 |
|---|---|---|
| Sensitivity | dBm | −110 |
| Input power threshold receiver overload | dBm | −40 |
| Antenna type | | linear array |
| Maximum antenna gain | dBi | 30 |
| Overall antenna coverage | ° | Elevation: −30 to +5<br>azimuth: −30 to +30<br>  |
| Instantaneous antenna azimuth gain mask pattern | |  <br>And with a zoom for azimuth angles from−10 to 10°<br>  |

TABLE 2 (*end*)

| Parameter | Units | Radar No. 3 |
|---|---|---|
| Instantaneous antenna elevation gain mask pattern | |  |



## 3 Operational characteristics of radionavigation systems in the frequency band 31.8-33.4 GHz

Aircraft radionavigation radars operating in the frequency band 31.8-33.4 GHz have two modes of operation. The first operate continuously during flight and the second operate only during approach on airports.

Mode 1: This mode encompasses an altitude range of from just off the ground to approximately 30 000 feet (9 000 m). Flight times can be up to six hours, and typically the majority of the time is spent en route, but some linger time at either the departure or destination points is expected. Up to 18 aircraft operating these radionavigation radars can be active in a small geographic area (i.e. separated by less than a kilometre from each other), though most often only 1-3 aircraft will be operating simultaneously together.

Mode 2: The second mode encompasses an altitude range of from just off the ground to below 500 feet (150 m) nominally and a maximum at 1 000 feet (300 m). Flight times depend on the time spent on approach. For nominal use only one aircraft is using the radar on the same airport but in some cases, it could be considered two aircraft on the approach using such radars.

## 4 Protection criteria

The desensitizing effect on radars from other services of a continuous-wave or noise-like type modulation is predictably related to its intensity. In any azimuth sectors in which such interference arrives, its power spectral density can, to within a reasonable approximation, simply be added to the power spectral density of the radar receiver thermal noise. If power spectral density of radar-receiver noise in the absence of interference is denoted by $N_0$ and that of noise-like interference by $I_0$, the resultant effective noise power spectral density becomes simply $I_0 + N_0$. An increase of about 1 dB would constitute significant degradation, equivalent to a detection-range reduction of about 6%. Such an increase corresponds to an $(I + N)/N$ ratio of 1.26, or an $I/N$ ratio of about −6 dB. This represents the aggregate effect of multiple interferers, when present; the tolerable $I/N$ ratio for an individual interferer depends on the number of interferers and their geometry, and needs to be assessed in the course of analysis of a given scenario. If continuous-wave interference were received from most azimuth directions, a lower $I/N$ ratio would need to be maintained.

The aggregation factor can be very substantial in the case of certain communication systems in which a great number of stations can be deployed.

The effect of pulsed interference is more difficult to quantify and is strongly dependent on receivers/processor design and mode of operation. In particular, the differential processing gains for

valid-target return, which is synchronously pulsed, and interference pulses, which are usually asynchronous, often have important effects on the impact of given levels of pulsed interference. Several different forms of performance degradation can be inflicted by such desensitization. Assessing it will be an objective for analyses of interactions between specific radar types. In general, numerous features of radiodetermination radars can be expected to help suppress low-duty cycle pulsed interference, especially from a few isolated sources. Techniques for suppression of low-duty cycle pulsed interference are contained in Recommendation ITU-R M.1372.