

ITU-R

Radiocommunication Sector of ITU

Recommendation ITU-R M.1464-2
(02/2015)

Characteristics of non-meteorological radiolocation radars, and characteristics and protection criteria for sharing studies for aeronautical radionavigation and radars in the radiodetermination service operating in the frequency band 2 700-2 900 MHz

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.

Policy on Intellectual Property Right (IPR)

ITU-R policy on IPR is described in the Common Patent Policy for ITU-T/ITU-R/ISO/IEC referenced in Annex 1 of Resolution ITU-R 1. Forms to be used for the submission of patent statements and licensing declarations by patent holders are available from <http://www.itu.int/ITU-R/go/patents/en> where the Guidelines for Implementation of the Common Patent Policy for ITU-T/ITU-R/ISO/IEC and the ITU-R patent information database can also be found.

Series of ITU-R Recommendations

(Also available online at <http://www.itu.int/publ/R-REC/en>)

Series	Title
BO	Satellite delivery
BR	Recording for production, archival and play-out; film for television
BS	Broadcasting service (sound)
BT	Broadcasting service (television)
F	Fixed service
M	Mobile, radiodetermination, amateur and related satellite services
P	Radiowave propagation
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, 2015

© ITU 2015

All rights reserved. No part of this publication may be reproduced, by any means whatsoever, without written permission of ITU.

RECOMMENDATION ITU-R M.1464-2

Characteristics of non-meteorological radiolocation radars, and characteristics and protection criteria for sharing studies for aeronautical radionavigation and radars in the radiodetermination service operating in the frequency band 2 700-2 900 MHz

(2000-2003-2015)

Scope

This Recommendation should be used for performing analyses between systems operating in the radiodetermination service and systems operating in other services. It should not be used for radar to radar analyses.

Keywords

Aeronautical, Radionavigation, Protection Criteria, Characteristics

Abbreviations/Glossary

AESA	Active electronically scanned array
ATC	Air traffic control
CFAR	Constant false alarm rate
CPIs	coherent processing intervals
CW	Carrier wave
MLT	Mean level threshold
PESA	Passive electronically scanned array
PPS	Pulses per second
PRF	Pulse repetition frequency
QPSK	Quadrature phase shift keying
STC	Sensitivity time control
TDMA	Time division multiple access
TWT	Travelling wave tube

The ITU Radiocommunication Assembly,

considering

- a) that antenna, signal propagation, target detection, and large necessary bandwidth characteristics of radar required to achieve their functions are optimum in certain frequency bands;
- b) that the technical characteristics of aeronautical radionavigation and non-meteorological radars are determined by the mission of the system and vary widely even within a frequency band;
- c) that the radionavigation service is a safety service as specified by No. **4.10** of the Radio Regulations (RR) and harmful interference to it cannot be accepted;

- 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 frequency bands between 420 MHz and 34 GHz used by radionavigation and meteorological radars;
- f) that representative technical and operational characteristics of radionavigation and meteorological radars are required to determine the feasibility of introducing new types of systems into frequency bands in which the latter are operated;
- g) that procedures and methodologies are needed to analyse compatibility between radionavigation and meteorological radars and systems in other services;
- h) that ground-based radars used for meteorological purposes are authorized to operate in this band on a basis of equality with stations in the aeronautical radionavigation service (see RR No. 5.423);
- i) that Recommendation ITU-R M.1849 contains technical and operational aspects of ground based meteorological radars and can be used as a guideline in analysing sharing and compatibility between ground based meteorological radars with systems in other services;
- j) that radars in this frequency band are employed for airfield surveillance which is a critical safety service at airfields, providing collision avoidance guidance to aircraft during approach and landing. Aviation regulatory authorities ensure and preserve safety and impose mandatory standards for minimum performance and service degradation,

recognizing

- 1 that the protection criteria depend on the specific types of interfering signals such as those described in Annexes 2 and 3;
- 2 that the application of protection criteria requires consideration for inclusion of the statistical nature of the criteria and other elements of the methodology for performing compatibility studies (e.g. antenna scanning and propagation path loss). Further development of these statistical considerations may be incorporated into future revisions of this and other related Recommendations, as appropriate,

recommends

- 1 that the technical and operational characteristics of the aeronautical radionavigation radars described in Annex 1 be considered representative of those operating in the frequency band 2 700-2 900 MHz;
- 2 that Recommendation ITU-R M.1461 be used as a guideline in analysing the compatibility between aeronautical radionavigation and meteorological radars with systems in other services;
- 3 that the protection trigger level for aeronautical radionavigation radars be based on Annex 2, in particular § 4, for assessing compatibility with interfering signal types from other services representative of those in Annex 2. These protection criteria represent the aggregate protection level if multiple interferers are present.

NOTE 1 – This Recommendation will be revised as more detailed information becomes available.

Annex 1

Characteristics of aeronautical radionavigation and non-meteorological radiolocation radars

1 Introduction

The frequency band 2 700-2 900 MHz is allocated to the aeronautical radionavigation service on a primary basis and the radiolocation service on a secondary basis. Ground-based radars used for meteorological purposes are authorized to operate in this frequency band on a basis of equality with stations in the aeronautical radionavigation service (see RR No. 5.423). The frequency band 2 900-3 100 MHz is allocated to the radionavigation and radiolocation services on a primary basis. The frequency band 3 100-3 400 MHz is allocated to the radiolocation service on a primary basis.

The aeronautical radionavigation radars are used for air traffic control (ATC) at airports, and perform a safety service (see RR No. 4.10). Indications are that this is the dominant frequency band for terminal approach/airport surveillance radars for civil air traffic worldwide.

2 Technical characteristics

The frequency band 2 700-2 900 MHz is used by several different types of radars on land-based fixed and transportable platforms. Functions performed by radar systems in the frequency band include ATC and weather observation. Radar operating frequencies can be assumed to be uniformly spread throughout the frequency band 2 700-2 900 MHz. The majority of systems use more than one frequency to achieve the benefits of frequency diversity. Two frequencies are very common and the use of four is not unknown. Table 1 contains technical characteristics of representative aeronautical radionavigation radars deployed in the frequency band 2 700-2 900 MHz. This information is sufficient for general calculation to assess the compatibility between these radars and other systems.

2.1 Transmitters

The radars operating in the frequency band 2 700-2 900 MHz use continuous wave (CW) pulses and frequency modulated (chirped) pulses. Cross-field, linear beam and solid state output devices are used in the final stages of the transmitters. The trend in new radar systems is toward linear beam and solid state output devices due to the requirement of Doppler signal processing. Also, the radars deploying solid state output devices have lower transmitter peak output power and higher pulsed duty cycles approaching 10%. There is also a trend towards radionavigation radar systems that use frequency diversity.

Typical transmitter RF emission bandwidths of radars operating in the frequency band 2 700-2 900 MHz range from 66 kHz to 6 MHz. Transmitter peak output powers range from 22 kW (73.4 dBm) for solid state transmitters, 70 kW (78.5 dBm) for travelling wave tube (TWT) systems, to 1.4 MW (91.5 dBm) for high power radars using klystrons and magnetrons.

In the high peak power systems it is normal to have a single transmitter per frequency and these tend to have narrow-band output stages. The lower peak power systems using TWTs or solid state have single transmitters capable of multifrequency operation. They thus have wideband output stages capable of multifrequency use.

TABLE 1
**Characteristics of aeronautical radionavigation radars in the
frequency band 2 700-2 900 MHz**

Characteristics	Units	Radar A	Radar B	Radar C	Radar D	Radar E	Radar F
Platform type (airborne, shipborne, ground)		Ground, ATC					
Tuning range	MHz	2 700-2 900 ⁽¹⁾					
Modulation		P0N		P0N, Q3N	P0N	P0N, Q3N	P0N, Q3N
Transmitter power into antenna ⁽²⁾	kW	1 400	1 320	25	450	22	70
Pulse width	μs	0.6	1.03	1.0, 89 ⁽³⁾	1.0	1.0, 55.0	0.4, 20 0.5, 27 ⁽⁴⁾
Pulse rise/fall time	μs	0.15-0.2		0.5/0.32 (short pulse) 0.7/1 (long pulse)			0.1 (typical)
Pulse repetition rate	pps	973-1 040 (selectable)	1 059-1 172	722-935 (short impulse) 788-1 050 (long impulse)	1 050	8 sets, 1 031 to 1 080	1 100 840 ⁽³⁾
Duty cycle	%	0.07 maximum	0.14 maximum	9.34 maximum	0.1 maximum		2 (typical)
Chirp bandwidth	MHz	Not applicable		2	Not applicable	1.3 non-linear FM	2
Phase-coded sub- pulse width		Not applicable					
Compression ratio		Not applicable		89	Not applicable	55	40:1 55:1
RF emission bandwidth: −20 dB 3 dB	MHz	6	5 0.6	2.6 (short impulse) 5.6 (long impulse) 1.9			3 (valeur type) 2
Output device		Klystron		Solid state transistors, Class C	Magnetron	Solid state transistors, Class C	TWT
Antenna pattern type (pencil, fan, cosecant-squared, etc.)	degrees	Cosecant-squared +30		Cosecant-squared 6 to +30			Cosecant- squared Enhanced to +40
Antenna type (reflector, phased array, slotted array, etc.)		Parabolic reflector					
Antenna polarization		Vertical or left hand circular polarization	Vertical or right hand circular polarization	Circular or linear	Vertical or left hand circular polarization	Vertical or right hand circular polarization	Left hand circular

TABLE 1 (continued)

Characteristics	Units	Radar A	Radar B	Radar C	Radar D	Radar E	Radar F
Antenna main beam gain	dBi	33.5		34	32.8	34.3 low beam 33 high beam	33.5
Antenna elevation beamwidth	degrees	4.8			4	4.8	5.0
Antenna azimuthal beamwidth	degrees	1.35	1.3	1.45	1.6	1.4	1.5
Antenna horizontal scan rate	degrees/s	75			90	75	90 60(4)
Antenna horizontal scan type (continuous, random, 360°, sector, etc.)		360°					
Antenna vertical scan rate	degrees/s	Not applicable					
Antenna vertical scan type (continuous, random, 360°, sector, etc.)	degrees	Not applicable		+2.5 to −2.5	Not applicable	Not applicable	Not applicable
Antenna side lobe (SL) levels (1st SLs and remote SLs)	dBi		+7.3	+9.5 3.5			+7.5 0 to −3 dBi
Antenna height	m	8					8-24
Receiver IF 3 dB bandwidth	MHz	13	0.7	1.1		1.2	4
Receiver noise figure	dB	4.0 maximum		3.3	2.7	2.1	2.0
Minimum discernible signal	dBm	−110	−108	−110	−112		−110 typical
Receiver front-end 1 dB gain compression point	dBm	−4	−6	−14			−10
Receiver on-tune saturation level	dBm		−45				
Receiver RF 3 dB bandwidth	MHz	13	12	345			400 ⁽¹⁾
Receiver RF and IF saturation levels and recovery times							
Doppler filtering bandwidth	Hz		95 per bin				
Interference-rejection features ⁽⁵⁾		Feedback enhancer	⁽⁶⁾				
Geographical distribution		Worldwide					
Fraction of time in use		100					
Platform type (airborne, shipborne, ground)		Ground, ATC			Ground, ATC		
Tuning range	MHz	2 700-2 900 ⁽⁷⁾			2 700-2 900 ⁽⁷⁾		
Modulation		P0N, Q3N			P0N, Q3N		
Transmitter power into antenna ⁽²⁾		40 kW			160 kW		
Pulse width	μs	1.0 (SP) 60.0 (LP)			1.0 (SP) ≤ 250.0 (LP)		
Pulse rise/fall time	μs	0.2 (SP), 3 (LP)			0.2 (SP), 3 (LP)		