



Recommendation ITU-R M.1796-2
(02/2014)

**Characteristics of and protection criteria for
terrestrial radars operating in the
radiodetermination service in the
frequency band 8 500-10 680 MHz**

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

Electronic Publication
Geneva, 2014

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RECOMMENDATION ITU-R M.1796-2

Characteristics of and protection criteria for terrestrial radars operating in the radiodetermination service in the frequency band 8 500-10 680 MHz*

(2007-2012-2014)

Scope

This Recommendation provides the technical and operational characteristics and protection criteria for radiodetermination systems operating in the frequency band 8 500-10 680 MHz. It was developed with the intention to support sharing studies in conjunction with Recommendation ITU-R M.1461 addressing analysis procedures for determining compatibility between radars operating in the radiodetermination service and other services.

Keywords

Radar, Protection criteria, Search radar, Interference, radiodetermination

Abbreviations/Glossary

CFAR Constant-false-alarm-rate

IMO International Maritime Organization

pps Pulses per second

SART Search and rescue transponder

The ITU Radiocommunication Assembly,

considering

- a) that antenna, signal propagation, target detection, and large necessary bandwidth characteristics of radars to achieve their functions are optimum in certain frequency bands;
- b) that the technical characteristics of radiodetermination radars are determined by the mission of the system and vary widely even within a frequency band;
- c) that ITU-R is considering the potential for the introduction of new types of systems or services in frequency bands between 420 MHz and 34 GHz used by radars in the radiodetermination service;
- d) that representative technical and operational characteristics of radars operating in the radiodetermination service are required to determine, if necessary, the feasibility of introducing new types of systems into frequency bands allocated to the radiodetermination service,

noting

- a) that technical and operational characteristics of maritime radar beacons operating in the frequency band 9 300-9 500 MHz are to be found in Recommendation ITU-R M.824;

* Characteristics of meteorological ground-based radars operating in this frequency band are contained in Recommendation ITU-R M.1849.

b) that technical parameters of radar target enhancers operating in the frequency band 9 300-9 500 MHz are to be found in Recommendation ITU-R M.1176;

c) that technical and operational characteristics of search and rescue radar transponders (SART) operating in the frequency band 9 200-9 500 MHz are to be found in Recommendation ITU-R M.628,

recognizing

a) that the required protection criteria depend upon the specific types of interfering signals;

b) that the application of protection criteria may require consideration for the inclusion of the statistical nature of the application of those criteria and other elements of the methodology for performing compatibility studies (e.g. propagation loss). Further development of these statistical considerations, together with the required probability of detection for various maritime operational scenarios may be incorporated into future revisions of this Recommendation, as appropriate,

recommends

1 that the technical and operational characteristics of the radiodetermination radars described in Annex 1 should be considered representative of those operating in the frequency band 8 500-10 680 MHz;

2 that this Recommendation, in conjunction with Recommendation ITU-R M.1461, should be used in analysing compatibility between radiodetermination radars and systems in other services;

3 that the criterion of interfering signal power to radar receiver noise power level, an I/N ratio of -6 dB, should be used as the required protection level for radiodetermination radars in the frequency band 8 500-10 680 MHz, even if multiple interferers are present (see Note 1);

4 that the results of interference susceptibility trials performed on shipborne radionavigation radars operating in the frequency band 9 200-9 500 MHz, which are contained in Annex 3, should be used in assessing interference into shipborne radionavigation radars, noting that the results are for non-fluctuating targets and that radar cross-section (RCS) fluctuations should be taken into account.

NOTE 1 – Further information is provided in Annex 2.

Annex 1

Technical and operational characteristics of radars in the radiodetermination service in the frequency band 8 500-10 680 MHz

1 Introduction

The characteristics of radiodetermination radars operating worldwide in the frequency band 8 500-10 680 MHz are presented in Tables 1, 2, 3 and 4, and described further in the following paragraphs.

2 Technical characteristics

The frequency band 8 500-10 680 MHz is used by many different types of radars on land-based, transportable, shipboard, and airborne platforms. Radiodetermination functions performed in the frequency band include airborne and surface search, ground-mapping, terrain-following, navigation (both aeronautical and maritime), target-identification, and meteorological (both airborne and ground-based). Other major differences among the radars include transmit duty cycles, emission bandwidths, presence and types of intra-pulse modulation, frequency-agile capabilities of some, transmitter peak and average powers, and types of transmitter RF power devices. These characteristics, individually and in combination, all have major bearing on the compatibility of the radars with other systems in their environment, while other characteristics affect that compatibility to lesser degrees. Radar operating frequencies can be assumed to be uniformly spread throughout each radar's tuning frequency band. Tables 1, 2, 3 and 4 contain technical characteristics of representative radiolocation and radionavigation radars deployed in the frequency band 8 500-10 680 MHz with the exception of ground based meteorological radars, which are contained in Recommendation ITU-R M.1849.

The major radiolocation radars operating in this frequency band are primarily used for detection of airborne objects. They are required to measure target altitude as well as range and bearing. Some of the airborne targets are small and some are at ranges as great as 300 nautical miles (~ 556 km), so these radiolocation radars must have great sensitivity and must provide a high degree of suppression to all forms of clutter return, including that from sea, land, and precipitation. In some cases, the radar emissions in this frequency band are required to trigger radar beacons.

Largely because of these mission requirements, the radars using this frequency band tend to possess the following general characteristics:

- they tend to have low to medium (from 1 W to 250 000 W) transmitter peak and average power, with notable exceptions;
- they typically use master-oscillator power-amplifier transmitters rather than power oscillators. They are usually tunable, and some of them are frequency-agile. Some of them use linear – or non-linear – FM (chirp) or phase-coded intra-pulse modulation;
- some of them have antenna main beams that are steerable in one or both angular dimensions using electronic beam steering;
- they typically employ versatile receiving and processing capabilities, such as auxiliary sidelobe-blanking receive antennas, processing of coherent-carrier pulse trains to suppress clutter return by means of moving-target-indication, constant-false-alarm-rate (CFAR) techniques, and, in some cases, adaptive selection of operating frequencies based on sensing of interference on various frequencies;
- individual radars often have numerous different pulse widths and pulse repetition frequencies; some chirp radars have a choice of chirp bandwidths; and some frequency-agile radars have a variety of agile- or fixed-frequency modes. This flexibility can provide useful tools for maintaining compatibility with other radars in the environment.

Some or all of the radars whose characteristics are presented in Tables 1, 2, 3 and 4 possess these properties. Those Tables are extensive to exemplify the wide variety of radar missions, platforms, waveforms, bandwidths, duty cycles, power levels, transmitter devices, etc. found in radars using this frequency band, although they do not illustrate the full repertoire of attributes that might appear in future systems.

TABLE 1

Characteristics of airborne radiodetermination radars operating in the frequency band 8 500-10 680 MHz

Characteristics	Units	System A1	System A2	System A3	System A4
Function		Search and track radar (multifunction)	Airborne search radar	Ground-mapping and terrain-following radar (multifunction)	Track radar
Tuning range	MHz	9 300-10 000	8 500-9 600	9 240, 9 360 and 9 480	10 000-10 500
Modulation		Pulse	Pulse	Non-coherent frequency-agile pulse-position modulation	CW, FMCW
Peak power into antenna	kW	17	143 (min) 220 (max)	95	1.5
Pulse widths and pulse repetition rates	μs pps	0.285; 8 200 to 23 000	2.5; 0.5 400 and 1 600	0.3, 2.35, and 4 2 000, 425 and 250	Not applicable
Maximum duty cycle		0.0132	0.001	0.001	1
Pulse rise/fall time	μs	0.01/0.01	0.02/0.2	0.1/0.1	Not applicable
Output device		Travelling wave tube	Tunable magnetron	Cavity-tuned magnetron	Travelling wave tube
Antenna pattern type		Pencil	Fan	Pencil	Pencil
Antenna type		Planar array	Parabolic reflector	Flat-plate planar array	Planar array
Antenna polarization		Linear	Linear	Circular	Linear
Antenna main beam gain	dB	32.5	34	28.3	35.5
Antenna elevation beamwidth	degrees	4.6	3.8	5.75	2.5
Antenna azimuthal beamwidth	degrees	3.3	2.5	5.75	2.5
Antenna horizontal scan rate	degrees/s	236 (118 scans/min)	36 or 72 (6 or 12 rpm)	Up to 106 (Up to 53 scans/min)	90
Antenna horizontal scan type (continuous, random, sector, etc.)		Sector: ±60° (mechanical)	360° (mechanical)	Sector: ±60° (mechanical)	Sector: ±60° (mechanical)

TABLE 1 (continued)

Characteristics	Units	System A1	System A2	System A3	System A4
Antenna vertical scan rate	degrees/s	118 (59 scans/min)	Not applicable	148.42 (Up to 137 scans/min)	90
Antenna vertical scan type		Sector: $\pm 60^\circ$ (mechanical)	Not applicable	Sector: $+25/-40^\circ$ (mechanical)	Sector: $\pm 60^\circ$ (mechanical)
Antenna side-lobe (SL) levels (1 st SLs and remote SLs)	dB _i	7.5 at 15°	Not specified	5.3 at 10°	Not specified
Antenna height		Aircraft altitude	Aircraft altitude	Aircraft altitude	Aircraft altitude
Receiver IF 3 dB bandwidth	MHz	3.1; 0.11	5	5.0, 1.8 and 0.8	0.48
Receiver noise figure	dB	Not specified	Not specified	6	3.6
Minimum discernible signal	dBm	-103	-107; -101	-101	
Total chirp width	MHz	Not applicable	Not applicable	Not applicable	Not specified
RF emission bandwidth – 3 dB – 20 dB	MHz	3.1; 0.11 22.2; 0.79	0.480; 2.7 1.5; 6.6	(Frequency and pulse width dependent) 100 to 118 102 to 120	Not specified Not specified

TABLE 1 (continued)

Characteristics	Units	System A5	System A6a ⁽¹⁾	System A6b ⁽¹⁾
Function		Weather avoidance including wind-shear detection (navigation)	Weather avoidance (WA), including wind-shear detection (WS) (navigation)	Ground-mapping, including: Monopulse ground mapping (MGM) and Doppler beam sharpening (DBS)
Tuning range	MHz	9 330	9 305-9 410 WA: frequency agile pulse-to-pulse ($\leq 2\,000$ hops/s); WS: adaptive single frequency	9 360 and 9 305-9 410 MGM: frequency agile pulse-to-pulse (≤ 600 hops/s); DBS: single frequency (9 360)
Modulation		Pulse	WA: unmodulated and Barker-coded (5:1 and 13:1) pulses; WS: unmodulated pulses	MGM and DBS: Barker-coded (13:1) pulses
Peak power into antenna	W	150	≤ 150	≤ 150
Pulse width and Pulse repetition rate	μs pps	1 to 20 180 to 9 000	WA: 0.2-230; WS: 2 WA: 2 000 pps for 0.2-6 μs pulses, decreasing to 230 pps for 230 μs pulses; WS: 3 600-3 940 pps	MGM: 1.3-260; DBS: 0.64-20 MGM: 600 pps for 1.3-60 μs pulses, decreasing to 220 pps for 260 μs pulses; DBS: 700-1 600 pps for all pulse widths
Maximum duty cycle		Not specified	WA: 0.054; WS: 0.0076	MGM: 0.057; DBS: 0.033 (0.024 long term)
Pulse rise/fall time	μs	Not specified	WA: 0.02-0.05/0.01; WS: 0.02/0.01	MGM: 0.01-0.02/0.01-0.02; DBS: 0.02-0.04/0.01
Output device		Solid state	FET	FET
Antenna pattern type		Pencil	Pencil	Fan
Antenna type		Planar array	Planar array	Planar array
Antenna polarization		Not specified	Linear	Linear
Antenna main beam gain	dBi	34.4	32	28.7
Antenna elevation beamwidth	degrees	3.5	4	42

TABLE 1 (continued)

Characteristics	Units	System A5	System A6a ⁽¹⁾	System A6b ⁽¹⁾
Antenna azimuthal beamwidth	degrees	3.5	2.7	2.7
Antenna horizontal scan rate	degrees/s	Not specified	≤ 200 (≤ 40 scans/min)	≤ 200 (≤ 40 scans/min)
Antenna horizontal scan type (continuous, random, sector, etc.)		Sector: ±30°	Sector: ±15 to ±135° (mechanical)	Sector: ±15 to ±135° (mechanical)
Antenna vertical scan rate		Not specified	≤ 20 scans/min	Not applicable
Antenna vertical scan type (continuous, random, sector, etc.)		Not specified	1 or 2 horizontal bars (mechanical)	Not applicable
Antenna side-lobe (SL) levels (1 st SLs and remote SLs)	dBi	+3.4	8 at 4.2°	3.7 at 4.5°
Antenna height		Aircraft altitude	Aircraft altitude (wind-shear at low altitude)	Aircraft altitude
Receiver IF 3 dB bandwidth	MHz	Not specified	WA: ≤ 16 for narrow pulses/subpulses, decreasing to 0.8 for wide pulses/subpulses; WS: ≥ 0.8	
Receiver noise figure	dB	4.0	5	5
Minimum discernible signal	dBm	−125	≥ −110	≥ −110
Chirp bandwidth	MHz	Not applicable	Not applicable	Not applicable
RF emission bandwidth	MHz	Not specified	For shortest plain pulse to longest subpulse: WA: 3 dB: 5 to 0.052; 20 dB: 40.5 to 0.37; WS: 3 dB: 0.46 20 dB: 3.28	For shortest to longest subpulses: MGM: 3 dB: 7.68 to 0.045; 20 dB: 59 to 0.31 DBS: 3 dB: 18 to 0.6; 20 dB: 150 to 4.1

TABLE 1 (continued)

Characteristics	Units	System A7a, A7b, and A7c ⁽²⁾	System A7d ⁽²⁾	System A7e and A7f ⁽²⁾	System A8
Function		Surface search and SAR imaging	Navigation	Inverse SAR imaging	Search (radiolocation) Weather
Tuning range	MHz	9 380-10 120	Frequency agile pulse-to-pulse over 340 MHz	9 380-10 120	9 250-9 440, frequency-agile pulse-to-pulse, 20 MHz steps
Modulation		Linear FM pulse	Linear FM pulse	Linear FM pulse	FM pulse
Peak power into antenna	kW	50	50	50	10
Pulse width and pulse repetition rate	µs pps	Search: 5 µs @ 1 600-2 000 or 10 µs @ approx. 380 SAR: 13.5 µs @ 250-750	10 Approx. 380	10 470, 530, 800 and 1 000	5 and 17 2 500, 1 500, 750 and 400 (all pulse widths)
Maximum duty cycle		0.010 (5 µs & 13.5 µs); 0.004 (10 µs)	0.004	0.010	0.04
Pulse rise/fall time	µs	0.1/0.1	0.1/0.1	0.1/0.1	0.1/0.1
Output device		Travelling wave tube	Travelling wave tube	Travelling wave tube	Travelling wave tube
Antenna pattern type		Pencil/fan	Pencil/fan	Pencil/fan	Fan
Antenna type		Parabolic reflector	Parabolic reflector	Parabolic reflector	Slotted array
Antenna polarization		Horizontal	Horizontal	Horizontal	Vertical and horizontal
Antenna main beam gain	dBi	34.5	34.5	34.5	32
Antenna elevation beamwidth	degrees	4.0	4.0	4.0	9.0
Antenna azimuthal beamwidth	degrees	2.4	2.4	2.4	1.8
Antenna horizontal scan rate	degrees/s	36, 360, and 1 800	36, 360, 1 800	36, 360, and 1 800	90 or 360 (15 or 60 rpm)

TABLE 1 (continued)

Characteristics	Units	System A7a, A7b, and A7c ⁽²⁾	System A7d ⁽²⁾	System A7e and A7f ⁽²⁾		System A8
Antenna horizontal scan type (continuous, random, sector, etc.)		10° sector	10° sector	10° sector		360°
Antenna vertical scan rate	degrees/s	Not applicable	Not applicable	Not applicable		Not applicable
Antenna vertical scan type (continuous, random, sector, etc.)		Selectable tilt 0°/–90°	Selectable tilt 0°/–90°	Selectable tilt 0°/–90°		Selectable tilt +15°/–15°
Antenna sidelobe (SL) levels (1 st SLs and remote SLs)	dBi	14.5 at 12°	14.5 at 12°	14.5 at 12°		20
Antenna height		Aircraft altitude	Aircraft altitude	Aircraft altitude		Aircraft altitude
Receiver IF 3 dB bandwidth	MHz	Not specified	Not specified	Not specified		16
Receiver noise figure	dB	5	5	5		Not specified
Minimum discernible signal	dBm	Depends on processing gain (34 dB (5 µs), 30 dB (10 µs) and 39.5 dB (13.5 µs) for one return pulse)	Depends on processing gain (17 dB for one return pulse)	Depends on processing gain (30 dB (100 MHz) or 33 dB (200 MHz) for one return pulse)		–98
Total chirp width	MHz	Search: 500 (5 µs) or 100 (10 µs) SAR: 660	5	100 or 200		10
RF emission bandwidth	MHz	Search (5 µs) Search (10 µs) SAR		100 MHz chirp	200 MHz chirp	
				95 110	190 220	
– 3 dB		470 95 640	4.5			9.3
– 20 dB		540 110 730	7.3			12













































Characteristics	Units	System A9	System A10	System A11	System A12
Function		Weather avoidance, search and rescue, ground mapping	Weather avoidance, ground mapping, search	Weather avoidance, ground mapping, search and rescue	Multipurpose Surveillance, scanning, Tracking
Tuning range	MHz	Radar: $9\,375 \pm 10$; Beacon: 9 310	Preheat pulse: 9 337 and 9 339 (precedes each operational pulse) Operational pulse: 9 344	$9\,375 \pm 30$	8 500-10 450
Modulation		Pulse	Pulse	Pulse	Adaptive Pulse, FM, linear FM pulse (chirp)
Peak power into antenna	kW	25	0.026 (14 dBW)	2.5 to 6.0	0.03-10
Pulse width and Pulse repetition rate	μs pps	4.5, 2.4, 0.8 and 0.2 μs at 180, 350, 350 and 1 000 pps	9 337 and 9 339 MHz: 1-29 μs at 2 200-220 pps (dithered) for all pulse widths; 9 344 MHz: 1.7-2.4, 2.4-4.8, 4.8-9.6, 17, 19 and 29 μs at 2 200-220 pps (dithered)	Fixed at 4 106.5	0.15-300 adaptive 1 000-50 000 adaptive
Maximum duty cycle		0.00082	9 337 and 9 339 MHz: ≤ 0.064 9 344 MHz: ≤ 0.011 (with 17 μs pulses)	0.00043	0.01-0.8 (pulse), 1 (FM)
Pulse rise/fall time	μs	Not specified	9 337 and 9 339 MHz: 0.3/0.2 9 344 MHz: 0.5/0.5	Rise time: 0.3 Fall time: 0.4	Not specified
Output device		High-reliability magnetron	IMPATT diode	Magnetron	Solid state
Antenna pattern type		Pencil and fan	Pencil	Pencil	Digital beamforming
Antenna type		Flat-plate array	Flat array	Flat array	Active array
Antenna polarization		Horizontal and vertical	Horizontal	Horizontal	Lin/circular
Antenna main beam gain	dBi	Pencil: 30; fan: 29	29	26.7	35-42
Antenna elevation beamwidth	degrees	Pencil: 3; fan: 6	< 10	8.1	1.6 @42 dBi
Antenna azimuthal beamwidth	degrees/s	Pencil: 3; fan: 3	7	8.1	1.6 @42 dBi

TABLE 1. (continued)

Characteristics	Units	System A9	System A10	System A11	System A12
Antenna horizontal scan rate	degrees/s	72 (long-range), 270 (short-range) (360°: 12 rpm (long-range), 45 rpm (short-range)) Sector: not specified	30	25	Not applicable
Antenna horizontal scan type (continuous, random, sector, etc.)		Continuous (360°) Sector (90°)	Sector 60° or 120°	Sector volume (90° or 120°)	±60° Electronic scan ±120° with additional mechanical repositioner
Antenna vertical scan rate	degrees/s	Not applicable	Not applicable	Not applicable	Not applicable
Antenna vertical scan type (continuous, random, sector, etc.)		Not applicable	Operator-selected tilt: ±30°	Sector volume: ±30°	±60° Electronic scan ±120° with additional mechanical repositioner
Antenna side-lobe (SL) levels (1 st SLs and remote SLs)	dBi	Not specified	+13.9	+4.7	depend on beamforming
Antenna height		Aircraft altitude	Aircraft altitude	Aircraft altitude	Aircraft altitude
Receiver IF 3 dB bandwidth	MHz	Not specified	2.0	1.0	not specified
Receiver noise figure	dB	6.5	2	5	6
Minimum discernible signal	dBm	Not specified	−128 (detection sensitivity after processing)	−110	−130
Total chirp width	MHz	Not applicable	Not applicable	Not applicable	Maximum 1.5 GHz for chirp modulation
RF emission bandwidth −3 dB	MHz	Not specified	−3 dB: 9 337 and 9 339 MHz: 0.7 9 344 MHz: 0.4, 0.25, 0.150, 0.075, 0.08, and 0.05	−3 dB: 0.5	Depending of operation mode
−20 dB		Not specified	−20 dB: 9 337 and 9 339 MHz: 3.6 9 344 MHz: 1.8, 1.5, 0.8, 0.375, 0.35, and 0.2	−20 dB: 1.5	Depending of operation mode

(1) Multimode radar; also has a beacon-interrogator mode at 9 375 MHz, not described herein.

(2) Multimode radar.

Characteristics	Units	System A13
Function		Unmanned Aircraft Detect and Avoid Radar
Tuning range	MHz	8 750-8 850 or 9 300-9 500 (selected to be compatible with other onboard avionics)
Modulation		Pulsed with intrapulse binary phase code; 3 dB bandwidth = 5 MHz
Peak power into antenna	kW	0.640 (net radiated)
Pulse width and Pulse repetition rate	μs pps	0.2 to 30 500 to 60 000 (mode-dependent)
Maximum duty cycle		0.16
Pulse rise/fall time	μs	0.1/0.1
Output device		Solid-state power amplifiers
Antenna pattern type		Elliptical beam cross-section
Antenna type		Active electronically scanned array (AESA)
Antenna polarization		Linear vertical
Antenna main beam gain	dBi	28
Antenna elevation beamwidth	degrees	13.5 at antenna broadside
Antenna azimuthal beamwidth	degrees	2.7 at antenna broadside

TABLE 1 (*end*)

Characteristics	Units	System A13
Antenna horizontal scan rate	degrees/s	Raster: 8 frames/min with interleaved track updates as required
Antenna horizontal scan type (continuous, random, sector, etc.)	degrees	Sector: ± 110 , electronically scanned (2 antennas are used)
Antenna vertical scan rate	degrees/s	Raster: 8 frames/min with interleaved track updates as required
Antenna vertical scan type (continuous, random, sector, etc.)	degrees	Sector: ± 15 (search), ± 45 (track); electronically scanned; field of regard is electronically stabilized with respect to a local horizontal plane
Antenna side-lobe (SL) levels (1 st SLs and remote SLs)	dBi	<17, first sidelobe; <13, outer sidelobes; (applies to transmit sidelobe levels with uniform weighting; receive sidelobe levels are lower)
Antenna height		equal to aircraft altitude
Receiver IF 3 dB bandwidth	MHz	5-10 (mode-dependent)
Receiver noise figure	dB	4.4 (system NF)
Minimum discernible signal	dBm	−129 for 10 dB SNR (equivalent signal power at the output of a lossless passive receive antenna, excluding antenna gain and including digital signal processing gain)
Total chirp width	MHz	10 if chirp is used (for possible growth modes); 5 for biphase code
RF emission bandwidth – 3 dB – 20 dB	MHz	5-10 (mode-dependent) 25

Characteristics of shipborne radiodetermination radars operating in the frequency band 8 500-10 680 MHz

Characteristics	Units	System S1	System S2	System S3	System S4		System S5
Function		Search and navigation radar	Track radar	Low altitude and surface search radar (multifunction)	Maritime radionavigation radar ⁽³⁾		Surface surveillance and navigation radar
Platform type		Shipborne, shore training sites	Shipborne	Shipborne	Shipborne		Shipborne
Tuning range	MHz	8 500-9 600	10 000-10 500	8 500-10 000	9 225-9 500		9 300-9 500
Modulation		Pulse	CW, FMCW	Frequency-agile pulse ⁽⁴⁾	Pulse		FMCW
Peak power into antenna	kW	35	13.3	10	5 (min)	50 (max)	1 10 ⁻⁶ to 10 ⁻³
Pulse width and pulse repetition rate	μs pps	0.1; 0.5 1 500; 750	Not applicable Not applicable	0.56 to 1.0; 0.24 19 000 to 35 000; 4 000 to 35 000	0.03 (min) at 4 000 (max)	1.2 (max) at 375 (min)	Not applicable 1 000 ⁽³⁾
Maximum duty cycle		0.00038	1	0.020	0.00045		1
Pulse rise/fall time	μs	0.08/0.08	Not applicable	0.028/0.03; 0.038/0.024	Not specified		Not applicable
Output device		Magnetron	Travelling wave tube	Travelling wave tube	Magnetron		Solid state
Antenna pattern type		Fan	Pencil	Pencil	Fan		Fan
Antenna type		Horn array	Planar array	Slotted array	Slotted array		Slotted waveguide
Antenna polarization		Linear	Linear	Linear	Not specified		Linear
Antenna main beam gain	dBi	29	43	39	27 (min)	32 (max)	30