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(01/2018)

Technical and operational characteristics of and protection criteria for aeronautical mobile service systems in the frequency bands 22.5-23.6 GHz and 25.25-27.5 GHz

M Series

Mobile, radiodetermination, amateur and related satellite services

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

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RECOMMENDATION ITU-R M.2114-0

Technical and operational characteristics of and protection criteria for aeronautical mobile service systems in the frequency bands 22.5-23.6 GHz and 25.25-27.5 GHz

(2018)

Scope

This Recommendation provides information on the technical characteristics and protection criteria for systems operating in the aeronautical mobile service (AMS) in the frequency bands 22.5-23.6 GHz and 25.25-27.5 GHz.

Related ITU Recommendations and Reports

Recommendations ITU-R M.1851, ITU-R P.2108, ITU-R P.676.

Keywords

Aeronautical mobile service systems, AMS, technical characteristics, protection criteria

Abbreviations/Glossary

ADL	AMS data link
ADT	Airborne data terminal
AMS	Aeronautical mobile service
GDT	Ground data terminal
RHCP	Right hand circularly polarised
RLOS	Radio-line-of-sight

The ITU Radiocommunication Assembly,

considering

that systems and networks operating in the aeronautical mobile service (AMS) are used for broadband and narrow-band airborne data links to support scientific research, remote sensing, fire-fighting, land and crop surveying, pipeline monitoring, and emergency management applications,

recognizing

a) that the frequency bands 22.5-23.6 GHz and 25.25-27.5 GHz are globally allocated on a primary basis to the mobile service;

b) that aeronautical mobile service (AMS) is a subset of the mobile service;

c) that the aeronautical mobile service is a mobile service between aeronautical stations and aircraft stations, or between aircraft stations;

d) that the use of systems operated under aeronautical mobile service does not preclude the use of these frequency bands by any current and planned application of the services to which they are allocated and does not establish any priority in the Radio Regulations;

e) that the frequency band 22.5-23.6 GHz is also allocated on a primary basis to the fixed, inter-satellite, and space research services in some or all parts of the frequency bands;

f) that the frequency band 25.25-27.5 GHz is also allocated on a primary basis to the earth exploration-satellite, fixed, fixed-satellite, inter-satellite, and space research services in some or all parts of the frequency bands;

g) that in these bands new systems under the mobile service as well as under the fixed service are currently envisaged and studied by ITU;

h) that operations of aeronautical mobile systems introduce more complex sharing over large areas and may require bilateral agreement between the administration operating AMS and affected administrations,

recommends

1 that the technical and operational characteristics of the systems operating in the AMS described in the Annex should be considered representative of those operating in the frequency bands 22.5-23.6 GHz and 25.25-27.5 GHz;

2 that the criterion of interfering signal power to receiver noise power level, *I/N*, of −6 dB should be used as the required protection level for AMS receivers. If multiple potential interference sources are present, protection of the AMS requires that this criterion is not exceeded due to the aggregate interference from the multiple sources.

Annex

Technical and operational characteristics of and protection criteria for aeronautical mobile service systems operating in the frequency bands 22.5-23.6 GHz and 25.25-27.5 GHz

1 Introduction

Systems and networks operating in the aeronautical mobile service (AMS) are used for broadband and narrow-band airborne data links to support scientific research, remote sensing, fire-fighting, land and crop surveying, pipeline monitoring, and emergency management applications.

The broadband data links are used to transmit data collected from one or multiple research/remote sensing equipment on the aircraft, and the narrow-band data links are used to control this remote sensing equipment on-board the aircraft.

2 Operational deployment

In the frequency bands 22.5-23.6 GHz and 25.25-27.5 GHz, the mobile service is allocated on a primary basis in all three ITU-R Regions. The AMS is a mobile service between aeronautical stations and aircraft stations, or between aircraft stations. Platforms equipped with AMS data links (ADL) can be deployed anywhere within a country whose administration has authorized their use in accordance with the authorization.

An ADL may exist between an airborne data terminal (ADT), which is an aircraft station, and a ground data terminal (GDT), which is an aeronautical station, or between two ADTs.

The GDT may be at a single permanent location or they may be transportable. Transportable GDTs can be moved to meet operational needs. The duration that a transportable GDT remains at a particular location is dependent upon operational requirements.

The link distance for the ADL is generally limited by the radio-line-of-sight (RLOS) horizon which is a function of the terrain in the vicinity of the GDT and the altitude of the ADT. The operational altitude of airborne platforms equipped with these ADLs depends on specific operational requirements and can be up to approximately 20 km. Although some of the link lengths may be relatively short, many of the link distances approach RLOS horizon distance. For an air-to-ground link, the link distance may be approximately 450 km.

The link between two ADTs operates in similar manner as the link between a GDT and an ADT with the exception that the link distance is a function of the operating altitude of the two ADTs. In the case of a direct air-to-air link, this link distance may be up to 900 km.

Other factors to consider, such as atmospheric losses (rain attenuation, gases, etc.) and clutter losses, as described in the relevant ITU-R Recommendations P-Series, could reduce the maximum distance of the link between two aircraft. Depending on the environmental conditions and locations of the aircraft, the crosslink distance might be shorter than 900 km.

A single GDT may support several ADT via different links. If the ADLs are operating in a narrow-band mode, multiple data links may be supported through frequency separation. If the data links are operating in a wide band mode, multiple data links may be supported through geographic separation using multiple high-gain, narrow-beam antennas.

An ADT may serve as a node within a larger network or as a repeater to extend the range between the data-collection ADT and the data-receiving GDT. In this case, the ADT may have two or more ADLs between either two ADTs or between one ADT and one GDT.

The temporal duration of the link can span the entire flight duration, i.e. take off/landing, transit to/from the operational area, and the time used for data collection in the operational area. Thus, the time duration during which an ADL can be active may extend for many hours.

3 Technical characteristics of aeronautical mobile systems

Representative technical characteristics for airborne data links in the AMS for the frequency bands 22.5-23.6 GHz and 25.25-27.5 GHz are provided in Table 1.

3.1 Transmitter characteristics

The aeronautical mobile systems operating or planned to operate in the frequency bands 22.5-23.6 GHz and 25.25-27.5 GHz typically use digital modulations. A given transmitter may be capable of radiating more than one waveform. Solid-state power amplifier output devices are typically used in the transmitters. The trend towards use of solid-state transmitters in new mobile systems will continue for the foreseeable future due to the wide bandwidth, low level of generated spurious emissions, low power consumption, and reliability of these devices.

Typical transmitter radio frequency emission (3 dB) bandwidths of mobile systems operating or planned to operate in the frequency bands 22.5-23.6 GHz and 25.25-27.5 GHz range from about 143 to 865 MHz. Transmitter peak output powers range from 0.1 W (20 dBm) to 60 W (48 dBm). However, the maximum power level at the input to the antenna is limited to 10 watts in the 25.25-27.5 GHz frequency range by RR No. **21.5**, and the equivalent isotropically radiated power is limited to 24 dBW (in any 1 MHz band) in the 25.25-27.5 GHz frequency range when the direction of maximum radiation of the antenna is within 1.5 degrees of the geostationary-satellite orbit by RR No. **21.2**.

3.2 Receiver characteristics

The aeronautical mobile systems in the frequency bands 22.5-23.6 GHz and 25.25-27.5 GHz use digital signal processing to enhance system performance.

The signal processing in the newer generation of aeronautical mobile systems may use direct sequence spread spectrum or other advanced techniques to produce a processing gain for the desired signal and may also provide suppression of undesired signals.

3.3 Antenna characteristics

A variety of different types of antennas may be used by systems in the frequency bands 22.5-23.6 GHz and 25.25-27.5 GHz. The antennas gain is typically in the range 33-46 dBi. Horizontal, vertical, and circular polarizations are used.

If antenna characteristics provided in Table 1 are sufficient, these characteristics should be used in sharing analyses. If additional characteristics are required, the first source of the data should be measured antenna characteristics. Otherwise the antenna data in Table 1 in conjunction with Recommendation ITU-R M.1851 should be used.

4 Protection criteria for the aeronautical mobile service in the frequency bands 22.5-23.6 GHz and 25.25-27.5 GHz

The performance of the communication link is often noise limited. An increase in receiver effective noise of 1 dB would constitute significant degradation in the communication range, equivalent to a reduction in communication range of approximately 10% in a free-space propagation environment.

An increase of 1 dB in the effective receiver noise level corresponds to an $(I + N)/N$ ratio of 1.26, or an I/N ratio of about −6 dB. Given the decrease in AMS range and increase in probability of bit error rate performance due to an increase in effective receiver noise level of 1 dB, the $I/N = -6$ dB value represents the required protection criterion for the AMS from interference due to another radiocommunication service. If multiple potential interference sources are present, protection of the AMS requires that this criterion is not exceeded due to the aggregate interference from the multiple sources.

TABLE 1

Representative technical characteristics of aeronautical mobile service systems in the frequency bands 22.5-23.6 GHz and 25.25-27.5 GHz

Parameter		Units	System 1 Airborne	System 1 Ground	System 2 Airborne	System 2 Ground
Transmitter						
Tuning range		GHz	25.75-27.15	22.9-23.3	25.25-27.5	22.55-23.5
Power output[(1)]		dBm	27 to 48	30 to 48	20 to 47	20 to 47
Bandwidth	3 dB	MHz	865	580	746	143
	20 dB	MHz	930	850	1 009	196
	60 dB	MHz	3 100	3 250	4 270	1 010
Harmonic attenuation		dB	65	65	62	62
Spurious attenuation		dB	60	60	60	60
Modulation			Digital	Digital	Digital	Digital
Receiver						
Tuning range		GHz	22.9-23.3	25.75-27.15	22.55-23.5	25.25-27.5
RF Selectivity	3 dB	MHz	1 410	2 410	3 299	3 299
	20 dB	MHz	1 540	2 620	3 510	3 510
	60 dB	MHz	1 850	3 300	3 940	3 940
IF Selectivity	3 dB	MHz	652	957	226	854
	20 dB	MHz	971	1 075	324	1 108
	60 dB	MHz	3 540	3 540	2 248	4 248
NF		dB	4	4	3.5	4.5
Sensitivity		dBm	−80.1	−79.7	−85.4	−79.1
Image rejection		dB	80	80	Not Available	Not Available
Spurious rejection		dB	65	65	75	75

TABLE 1 (*end*)

Parameter	Units	System 1 Airborne	System 1 Ground	System 2 Airborne	System 2 Ground
Antenna					
Antenna gain	dBi	33	36-46	33	33-46
1st sidelobe	dBi	17	18	16	16
Polarization		RHCP(2)	RHCP(2)	RHCP(2)	RHCP(2)
Antenna pattern/Type		Parabolic reflector	Parabolic reflector	Parabolic reflector	Parabolic reflector
Horizontal BW	degrees	3.0	2.7	7.2	7.2
Vertical BW	degrees	3.0	2.7	7.2	7.2
Antenna model		Recommendation ITU-R M.1851(3) (uniform distribution)	Recommendation ITU-R M.1851(3) (uniform distribution)	Recommendation ITU-R M.1851(3) (uniform distribution)	Recommendation ITU-R M.1851(3) (uniform distribution)

Notes:

(1) In the frequency range 25.25-27.5 GHz, RR No. **21** (§ **21.2** and **21.5**) apply.

(2) RHCP – Right Hand Circularly Polarized.

(3) Recommendation ITU-R M.1851 provides several patterns based on the field distribution across the aperture of the antenna. The suggested distribution for modelling the antennas is shown in the parenthetical text based on guidance in Recommendation ITU-R M.1851.