

# ITU-R

Radiocommunication Sector of ITU

**Recommendation ITU-R M.2089-0**  
(10/2015)

## **Technical characteristics and protection criteria for aeronautical mobile service systems in the frequency range 14.5-15.35 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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<b>BR</b>	Recording for production, archival and play-out; film for television
<b>BS</b>	Broadcasting service (sound)
<b>BT</b>	Broadcasting service (television)
<b>F</b>	Fixed service
<b>M</b>	<b>Mobile, radiodetermination, amateur and related satellite services</b>
<b>P</b>	Radiowave propagation
<b>RA</b>	Radio astronomy
<b>RS</b>	Remote sensing systems
<b>S</b>	Fixed-satellite service
<b>SA</b>	Space applications and meteorology
<b>SF</b>	Frequency sharing and coordination between fixed-satellite and fixed service systems
<b>SM</b>	Spectrum management
<b>SNG</b>	Satellite news gathering
<b>TF</b>	Time signals and frequency standards emissions
<b>V</b>	Vocabulary and related subjects

*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.2089-0

**Technical characteristics and protection criteria for aeronautical mobile service systems in the frequency range 14.5-15.35 GHz**

(2015)

**Scope**

This Recommendation provides information on the technical characteristics and protection criteria for systems operating in the aeronautical mobile service (AMS), planned to or currently operating in the frequency range 14.5-15.35 GHz for use in sharing and compatibility studies as needed.

**Keywords**

Aeronautical Mobile Service, Technical Characteristics, Protection Criteria, Ku-band

**Abbreviations/Glossary**

ADL	AMS data link
ADT	Airborne data terminal
AMS	Aeronautical mobile service
GDT	Ground data terminal
RLOS	Radio line-of-sight
UAS	Unmanned aircraft system

The ITU Radiocommunication Assembly,

*considering*

- a)* that systems and networks operating in the AMS are used for broadband, airborne data links to support remote sensing applications in the areas of, e.g. earth sciences, land management, and energy distribution. Examples of these applications include e.g. monitoring sea ice thickness and distribution, local and national law enforcement, forest fire mapping, petroleum pipeline monitoring, agricultural and urban land use and natural resource surveys;
- b)* that systems and networks operating in the AMS are used for narrow-band, airborne command and control data links;
- c)* that there are increasing numbers of various planned and operating systems and networks in the AMS;
- d)* that administrations conducting ITU-R sharing or compatibility studies addressing new allocation proposals in any part of the frequency range 14.5-15.35 GHz should take into account operations of incumbent services in the band, including aeronautical mobile service,

*recognizing*

- a)* that the frequency range 14.5-15.35 GHz is globally allocated on a primary basis to the mobile service;
- b)* that the aeronautical mobile service is a mobile service between aeronautical stations and aircraft stations, or between aircraft stations;
- c)* that the frequency range 14.5-15.35 GHz is also globally allocated on a primary basis to fixed service;

d) that the frequency range 14.5-14.8 GHz is also globally allocated on a primary basis to the fixed-satellite service (Earth-to-space) under the provisions of RR No. **5.510**,

*recognizing further*

a) that in Regions 1 and 3, the use of the frequency range 14.5-14.8 GHz by the broadcasting satellite service for feeder links (Earth-to-space), is reserved for countries outside Europe operating under the provisions and associated plans of Appendix **30A** to the Radio Regulations;

b) that the use of the frequency range 14.5-14.8 GHz by the AMS in no way restricts or limits the operation of feeder link to broadcasting satellite service referred to in *recognizing further a)* above;

c) that the use of the frequency range 14.5-15.35 GHz by the AMS must take into account the operation of the fixed service referred to in *recognizing c)* above,

*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 range 14.5-15.35 GHz;

**2** that the technical characteristics and protection criteria for AMS receiving and transmitting stations given in the Annex should be used in performing sharing and compatibility analyses as needed.

## **Annex**

### **Technical characteristics and protection criteria for aeronautical mobile service systems in the frequency range 14.5-15.35 GHz**

#### **1 Introduction**

Systems and networks operating in the AMS are increasingly used by local and national governments, as well as civil sector and educational entities, for broadband, airborne data links to support remote sensing applications e.g. earth sciences, land management, and energy distribution. Examples of these applications include, e.g. monitoring Arctic sea ice thickness and distribution, local and national law enforcement, forest fire mapping, pipeline monitoring, agricultural and urban land use, and natural resource surveys). The remote sensing equipment may be on board either manned aircraft or unmanned aeronautical systems (UAS). In the case where the remote sensing equipment is on board a UAS, systems and networks operating in the AMS may be used for narrow-band, airborne command and control data links. These narrow-band data links may be used to command and control either or both the remote sensor equipment and the UAS.

#### **2 Operational deployment**

In the frequency range 14.5-15.35 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. ADLs are bidirectional by design and may operate in either a narrow-band or wideband mode in one or both directions depending upon operational requirements.

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 vary 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, this link distance may be approximately 450 km for an AMS data link at an altitude of approximately 20 km.

The link between two ADTs operates in the same 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 approximately 900 km. Other factors to consider, such as atmospheric losses (rain attenuation, gases, etc.) and clutter losses, as described in the 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 ground terminal may support several aeronautical terminals 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 wideband mode, multiple data links may be supported through geographic separation using multiple high-gain, narrow-beam antennas.

The 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.

During the flight, tracking of directional AMS antennas (both GDT and ADT) are maintained using information exchanged through the link. In case of link loss, antenna tracking information is also lost, and due to aircraft movement, the correct antennas pointing could be no longer maintained. In this case, a full link recovery procedure must be initiated, and the duration of that interruption of service depends on the aircraft speed and the position of the pre-planned rendezvous point that the aircraft must reach to resume the communication.

### **3 Technical characteristics of aeronautical mobile systems**

Representative technical characteristics for airborne data links in the AMS for the frequency range 14.5-15.35 GHz are provided in Table 1.

#### **3.1 Transmitter characteristics**

The aeronautical mobile systems operating or planned to operate in the frequency band 14.5-15.35 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 RF emission (3 dB) bandwidths of mobile systems operating or planned to operate in the frequency band 14.5-15.35 GHz range from about 0.3-120 MHz. Transmitter peak output powers range from 0.001 W (0 dBm) to 100 W (50 dBm) and are adjustable. However, the maximum power level at the input to the antenna is limited to 10 dBW in the 14.5-14.8 GHz frequency range by RR Article **21.5**. Within the frequency range of 14.5-14.8 GHz, the transmitted power can be adjusted such that it operates within the isotropically radiated power of 45 dBW when the direction of maximum radiation of the antenna is within 1.5 degrees of the geostationary-satellite orbit by RR Article **21.2**.

### **3.2 Receiver characteristics**

The newer generation of aeronautical mobile systems in the frequency range 14.5-15.35 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 are used by systems in the frequency range 14.5-15.35 GHz. Antennas in this band are generally of a variety of sizes and vary between the airborne component of the link and the ground based component of the link. The airborne antennas gain is typically in the range  $-3$  to 27.5 dBi. The ground-based antenna gain is typically in the range 0-45 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 range 14.5-15.35 GHz**

When operating near the maximum radio line-of-sight distance separation between the transmitter and receiver, the performance of the communication link is often noise limited. An increase in receiver effective noise of 1 dB would constitute significant degradation communication range, equivalent to a reduction in communication range of approximately 10% in a free-space propagation environment.

Such an increase effective receiver noise corresponds to an  $(I + N)/N$  ratio of 1.26, or an  $I/N$  ratio of about  $-6$  dB. This 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.

It is noted that, in the case where an administration wishing to operate an AMS system does not have bilateral coordination agreements with affected administrations, the level of interference from existing stations in the fixed service may exceed this protection criteria. Sharing studies should take this into account.

TABLE 1

**Representative technical characteristics of the aeronautical mobile service systems in the frequency range 14.5-15.35 GHz**

Parameter		Units	System 1 Airborne	System 1 Ground	System 2 Airborne	System 2 Ground
Transmitter						
Tuning range		GHz	15.15-15.35	14.50-14.83	14.50-14.83	15.15-15.35
Power output <sup>1</sup>		dBm	0 to 30	30 to 50	20	30 to 50
Bandwidth	3 dB	MHz	0.354 / 3.5 / 10 / 120	0.354 / 3.5 / 10 / 60 / 120	0.354 / 3.5 / 10 / 60 / 120	0.354 / 3.5 / 10 / 120
	20 dB	MHz	21 / 21.4 / 57.4 / 285	21 / 25 / 60 / 190 / 400	21 / 25 / 60 / 190 / 400	21 / 21.4 / 57.4 / 285
	60 dB	MHz	108 / 181 / 219 / 630	100 / 110 / 120 / 240 / 480	100 / 110 / 120 / 240 / 480	108 / 181 / 219 / 630
Harmonic attenuation		dB	65	60	60	65
Spurious attenuation		dB	80	52	52	80
Modulation			OQPSK	OQPSK	OQPSK	OQPSK
Receiver						
Tuning range		GHz	14.50-14.83	15.15-15.35	15.15-15.35	14.50-14.83
RF selectivity	3 dB	MHz	520	440	440	520
	20 dB	MHz	580	587	587	580
	60 dB	MHz	720	700	700	720
IF selectivity	3 dB	MHz	36 / 140	27 / 150	27 / 150	36 / 140
	20 dB	MHz	67 / 400	46 / 210	46 / 210	67 / 400
	60 dB	MHz	173 / 850	113 / 600	113 / 600	173 / 850
NF		dB	4	5	5	4
Sensitivity		dBm	−75 to −80	−105 to −110	−105 to −110	−75 to −80
Image rejection		dB	80	100	100	80
Spurious rejection		dB	60	50	50	60

TABLE 1 (continued)

Parameter	Units	System 1 Airborne	System 1 Ground	System 2 Airborne		System 2 Ground	
Antenna							
Antenna gain	dBi	24	40	27	7.2	44	3
1 <sup>st</sup> sidelobe	dBi	5.5 @ 21°	20 @ 2.5°	9.7 @ 12°	N/A <sup>2</sup>	21 @ 2.3°	N/A <sup>2</sup>
Polarization		RHCP <sup>3</sup>	RHCP <sup>3</sup> & LHCP <sup>4</sup>	RHCP <sup>3</sup> & LHCP <sup>4</sup>	Not available	RHCP <sup>3</sup>	Vertical
Antenna pattern/type		RF lens	Parabolic reflector	Parabolic reflector	Biconical dipole	Parabolic reflector	Dipole
Horizontal BW	degrees	12	1.5	8	360	1.7	360
Vertical BW	degrees	12	1.5	8	16	1.7	42
Antenna model		Recommendation ITU-R M.1851 <sup>5</sup> (Uniform distribution)	Recommendation ITU-R M.1851 <sup>5</sup> (Cosine distribution)	Recommendation ITU-R M.1851 <sup>5</sup> (Uniform distribution)	Omnidirectional	Recommendation ITU-R M.1851 <sup>5</sup> (Cosine distribution)	Omnidirectional

Notes:

- (1) In the frequency band 14.5-14.8 GHz, RR Articles **21** (§§ 21.2, 21.3 and 21.5) apply.
- (2) N/A – Not applicable.
- (3) RHCP – Right Hand Circularly Polarized.
- (4) LHCP – Left Hand Circularly Polarized.
- (5) 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.

TABLE 1 (continued)

Parameter		Units	System 3 Airborne	System 3 Ground	System 4 Airborne	System 4 Ground
Transmitter						
Tuning range		GHz	14.50-15.35	14.83-15.35	14.50-14.83	15.15-15.35
Power output <sup>1</sup>		dBm	0 to 30	40	40	50
Bandwidth	3 dB	MHz	0.354 / 3.5 / 40	34	3.4 / 10.3 / 20.6 / 27.8 / 42.9	9.15
	20 dB	MHz	21 / 21.4 / 85	44	7 / 18.8 / 37.6 / 78.5 / 112	36.6
	60 dB	MHz	108 / 181 / 190	45.6	20 / 67.2 / 134 / 281 / 320	76.6
Harmonic attenuation		dB	65	65	65	65
Spurious attenuation		dB	80	80	80	80
Modulation			OQPSK	16 APSK	QPSK, OQPSK	OQPSK
Receiver						
Tuning range		GHz	14.83-15.35	14.50-15.35	15.15-15.35	14.50-14.83
RF selectivity	3 dB	MHz	520	440	307	340
	20 dB	MHz	580	587	325	400
	40 dB		Not available	Not available	399	540
	60 dB	MHz	720	700	Not available	Not available
IF selectivity	3 dB	MHz	50	50	130	36.5
	20 dB	MHz	85	70	400	59.1
	60 dB	MHz	135	120	1 200	103.7
NF		dB	5	4	4.5	6
Sensitivity		dBm	−99	−105 to −110	−106	−92
Image rejection		(dB)	100	100	80	85
Spurious rejection		(dB)	50	50	60	85

TABLE 1 (continued)

Parameter	Units	System 3 Airborne	System 3 Ground	System 4 Airborne		System 4 Ground	
Antenna							
Antenna gain	dBi	24	45	3.7	19.5	3	40
1 <sup>st</sup> sidelobe	dBi	5.5 @ 21°	20	N/A <sup>2</sup>	3.5 @ 20° (azimuth) 4.0 @ 23° (elevation)	N/A <sup>1</sup>	22
Polarization		RHCP <sup>3</sup>	RHCP <sup>3</sup>	RHCP <sup>3</sup>	RHCP <sup>3</sup>	RHCP <sup>3</sup>	RHCP <sup>3</sup>
Antenna pattern/type		RF lens	Parabolic reflector	Biconical dipole	RF lens	Biconical dipole	Parabolic reflector
Horizontal BW	Degrees	12	1.11	360	12	360	3.8
Vertical BW	Degrees	12	1.11	40	12	42	3.8
Antenna model		Recommendation ITU-R M.1851 <sup>5</sup> (Uniform distribution)	Recommendation ITU-R M.1851 <sup>5</sup> (Cosine distribution)	Omnidirectional	Recommendation ITU-R M.1851 <sup>5</sup> (Uniform distribution)	Omnidirectional	Recommendation ITU-R M.1851 <sup>5</sup> (Uniform distribution)

Notes:

- (<sup>1</sup>) In the frequency band 14.5-14.8 GHz, RR Articles **21** (§§ 21.2, 21.3 and 21.5) apply.
- (<sup>2</sup>) N/A – Not applicable.
- (<sup>3</sup>) RHCP – Right Hand Circularly Polarized.
- (<sup>4</sup>) LHCP – Left Hand Circularly Polarized.
- (<sup>5</sup>) 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.

TABLE 1 (continued)

Parameter		Units	System 5 Airborne	System 5 Ground	System 6 Airborne / Ground / Shipboard terminals
Transmitter					
Tuning range		GHz	14.5-15.35	N/A <sup>2</sup>	14.5-15.35
Power output		dBm	10 to 50	N/A <sup>2</sup>	20 to 43
Bandwidth	3 dB	MHz	0.8 / 8.6 / 11.6 / 40.6 / 43.6	N/A <sup>2</sup>	0.8 to 100
	20 dB	MHz	1.2 / 12.1 / 16.1 / 57 / 61.2	N/A <sup>2</sup>	1.2 to 120
	60 dB	MHz	9.8 / 24.4 / 32.6 / 114 / 122	N/A <sup>2</sup>	9.8 to 160
Harmonic attenuation		dB	65	N/A <sup>2</sup>	60
Spurious attenuation		dB	70	N/A <sup>2</sup>	60
Modulation			QPSK/8PSK	N/A <sup>2</sup>	PSK/QPSK/8PSK
Receiver					
Tuning range		GHz	N/A <sup>2</sup>	14.5-15.35	14.5-15.35
RF selectivity	3 dB	MHz	N/A <sup>2</sup>	800	100
	20 dB	MHz	N/A <sup>2</sup>	830	120
	60 dB	MHz	N/A <sup>2</sup>	990	160
IF selectivity	3 dB	MHz	N/A <sup>2</sup>	0.85 / 8.8 / 11.7 / 40.7 / 43.7	0.85 to 120
	20 dB	MHz	N/A <sup>2</sup>	1.3 / 18 / 23 / 90 / 90	1.3 to 120
	60 dB	MHz	N/A <sup>2</sup>	3;2 / 61; 81; 320 / 320	3.2 to 160
NF		dB	N/A <sup>2</sup>	3.5	3.5
Sensitivity		dBm	N/A <sup>2</sup>	Up to -111	Up to -108
Image rejection		(dB)	N/A <sup>2</sup>	80	65
Spurious rejection		(dB)	N/A <sup>2</sup>	60	60

TABLE 1 (*end*)

Antenna				
Antenna gain	dBi	−3 to 27.5	42.5	0 to 12
1 <sup>st</sup> sidelobe	dBi	N/A <sup>2</sup>	22.5	N/A <sup>2</sup>
Polarization		RHCP <sup>3</sup>	RHCP <sup>3</sup>	Vertical / RHCP <sup>3</sup>
Antenna pattern/type		Dipole / Parabolic reflector	Parabolic reflector	Dipole / Phase array
Horizontal BW	Degrees	360 to 7	1	360 to 45
Vertical BW	Degrees	90 to 7	1	90 to 45
Antenna model		Omnidirectional or Recommendation ITU-R M.1851 <sup>5</sup> (Uniform distribution)	Recommendation ITU-R M.1851 <sup>5</sup> (Cosine distribution)	Not available

Notes:

- (<sup>1</sup>) In the frequency band 14.5-14.8 GHz, RR Articles **21** (§§ 21.2, 21.3 and 21.5) apply.
- (<sup>2</sup>) N/A – Not applicable.
- (<sup>3</sup>) RHCP – Right Hand Circularly Polarized.
- (<sup>4</sup>) LHCP – Left Hand Circularly Polarized.
- (<sup>5</sup>) 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.