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| U.S. Radiocommunications Sector  Fact Sheet | |
| **Working Party:** ITU-R WP 5B | **Document No:** USWP5B27-17-FS |
| **Ref:** WP-5B/355Annex 16 | **Date:** August 10, 2021 |
| **Document Title:** WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT REVISION TO RECOMMENDATION ITU-R M.2116-0  **Technical characteristics and protection criteria for the systems operating in the aeronautical mobile service and maritime mobile service within the 4 400-4 990 frequency range** | |
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| **Purpose/Objective:** Continue to revise Recommendation ITU-R M.2116-0 | |
| **Abstract:** This contribution propose to make further update. | |
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| **Radiocommunication Study Groups** | Logo  Description automatically generated |
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| Received:  Source: Document 5B/335 (Annex 16) | **Document 5B/288-E** |
| **XX November 2021** |
| **English only** |
| **United States of America** | |
| Working document for a Preliminary draft revision to Recommendation itu-r M.2116-0 | |
| **Technical characteristics and protection criteria for the aeronautical mobile service systems operating within the 4 400-4 990 MHz frequency range** | |

**1 Introduction**

At the twenty-sixth meeting of Working Party 5B (e-meeting, May 2021) the meeting agreed to initiate a revision to Recommendation ITU-R M.2116. This contribution seeks to continue the development of this revision.

**2 Proposal**

The United States proposes the following edits contained in Attachment 1.

**Attachment:** 1

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| **ATTACHMENT** |
| WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT REVISION TO RECOMMENDATION ITU-R M.2116-0 |
| **Technical characteristics and protection criteria for the systems operating in the aeronautical mobile service and maritime mobile service within the 4 400-4 990 MHz frequency range** |

(2018-20xx)

*[Editor’s note: the following elements of main body of the Recommendation were not discussed nor agreed at WP 5B meeting in May 2021.]*

*[Editor’s note: The scope of this recommendation may need to be reviewed not to be limited to the technical characteristics for sharing and compatibility studies but also for operations]*

**Scope**

This Recommendation provides information on the technical characteristics and protection criteria for systems operating in the aeronautical mobile service (AMS) and maritime mobile service (MMS) planned to or currently operating within the frequency range 4 400-4 990 MHz for use in sharing and compatibility studies as needed and does not contain any aeronautical mobile telemetry system.

**Keywords**

Aeronautical mobile service, maritime mobile service, technical characteristics, protection criteria

**Abbreviations/Glossary**

ADL Aeronautical mobile service data link

AMS Aeronautical mobile service

MDL Maritime mobile service data link

MMS Maritime mobile service

**Related ITU-R Recommendations and Reports**

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 systems and networks operating in the aeronautical mobile service (AMS) are used for broadband, data-links including aircraft to aircraft links, to support various applications as remote sensing, e.g. earth sciences, land management, energy distribution, ;

*b)* that systems and networks operating in the maritime mobile service (MMS) are used, for broadband, maritime data-links including ship to aircraft links, to support various applications as remote sensing, e.g. earth sciences, land management, energy distribution;

*c)* that systems and networks operating in AMS and MMS are also used for narrow-band, airborne data-links;

*d)* that the physics of the propagation of electromagnetic energy, the availability of hardware components, etc., within the 4 400‑4 990 MHz frequency range facilitates the use of current or planned operating systems and networks for applications referenced in *considering* *a)*, *b)* and *c)*,

*recognizing*

*a)* that the frequency range 4 400-4 990 MHz is allocated on a primary basis in all three ITU regions to the mobile service;

*b)* that other radio services are allocated on either a primary or secondary basis in all or parts of the frequency range 4 400-4 990 MHz all three ITU Regions;

*c)* that the RR No. **5.442** provides some restrictions for the use of AMS in parts of the frequency band;

*d)* that technical characteristics and protection criteria for aeronautical mobile telemetry systems are not contained in this Recommendation,

*recommends*

**1** that the technical characteristics and protection criteria for systems operating in the AMS given in the Annex 1 should be used in performing sharing and compatibility analyses.

**2** that the technical characteristics and protection criteria for systems operating in the MMS given in Annex 2 should be used performing sharing and compatibility analyses.

**3** that the following Note is considered as part of this Recommendation.

NOTE – The characteristics and protection criteria should not have any adverse effect to Appendix **30B** of the Radio Regulations-

**Annex 1  
  
Technical characteristics and protection criteria for systems operating in the aeronautical mobile service**

*[Editor’s note: During WP 5B meeting, views were expressed regarding the implication of ICAO status of the band 4 800-4 990 MH as well as its usage by administrations.*

*View 1: In this connection, WP 5B would like to bring to the attention to WP 5D that in this frequency band AMS system are not standardised by ICAO however they are currently used by some administrations. There are instances where AMS stations operating in international space/waters do not require specific measures for protections.*

*View 2: There are other instances where a WRC decided to define protection to aeronautical mobile stations operating in international areas in bands not standardized by ICAO e.g. RR No.****5.509D****. (end of View 2)*

*The current version revision of ITU-R Recommendation ITU-R* [*M.2116-0*](https://www.itu.int/rec/R-REC-M.2116-0-201801-I/en) *and Report ITU-R* [*M.2119-0*](https://www.itu.int/pub/R-REP-M.2119-2007) *contains characteristics as well as protection criteria for certain systems in the aeronautical mobile service in the frequency band 4 800-4 990 MHz. It should be checked if the above mentioned documents including their possible revisions contain necessary information (e.g. deployment parameters) for sharing studies of AMS and MMS stations located in the international airspace / waters.]*

**1 Introduction**

[Systems and networks operating in the AMS are used for broadband, airborne data-links including aircraft to aircraft, to support various applications as remote sensing, e.g. earth sciences, land management, energy distribution.

These aeronautical mobile systems (uplink, downlink and air-air) operate on a 24/7 basis to support security, law enforcement, and humanitarian assistance efforts..]

*[Editor’s Note: the section needs to be specified taking into account the actual use of AMS, including use in international airspace]*

**2 Operational deployment**

*[Editor’s Note: in this section certain points should be considered further:*

*a) the tasks to be performed by AMS systems for all systems*

*b) the geographical area of use for systems*

*c) the time utilization factors for the operations of the AMS systems*

*View 1 on a) b) and c): that the sentence (in section Introduction) “These aeronautical and maritime mobile systems (uplink, downlink and air-air) operate on a 24/7 basis to support security, law enforcement, and humanitarian assistance efforts throughout the 4 800-4 990 MHz frequency range” covers a) b) and c)*

*d) the planned usage of the 4 800-4 990 MHz band (spectrum required, possibility of using only the selected parts of the 4 800-4 990 MHz band, frequency hopping and selection of the working channel, including moving to another band, e.g. 4 400-4 800 MHz, etc.)]*

*View 1 on d) that such information is not needed to undertake the sharing studies as the purpose of this Recommendation is not to identify “if” systems should move in frequency or not or should only occupy a certain portion of 4400-4990 MHz.*

*View 2:*

*It is necessary to specify in sufficient level of detail the actual operational profiles of the considered AMS and MSS systems, not least from the spectrum usage efficiency point of view. Non-registered in MIFR systems cannot “reserve” for their potential operation international space and waters, nor can they be granted protection on a 24/7 basis globally. Only actual operations could be considered for possible protection, not the potential availability. For example Rec ITU-R M.2114 describe operation of ADL as “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..." It is therefore necessary to find a balanced solution which would be based on geographical, time or frequency separation between IMT and AMS/MMS applications, or on a combination thereof]*

*[Editor’s note: this paragraph requires further consideration, in particular authorization issue and its relevance to this Recommendation. It needs to be checked if the information is already covered in the following text]*

[Aeronautical mobile data links are operated between aeronautical stations and aircraft stations, or between aircraft stations or ship stations equipped with AMS data links (ADL) and can be deployed anywhere except within countries whose administration has not authorized their use.]ADL includes transmission from and to, either aircraft stations or a ground terminal considered as an aeronautical station. These transmissions could use bidirectional air‑to‑ground links, or relay through another airborne platform using an air‑to‑air data link. Links can be either simplex or duplex. The link lengths vary greatly in these applications. Although some of the link lengths may be relatively short, many of the link lengths approach the radio line‑of‑sight distance. The operational altitude of airborne platforms equipped with these ADLs can vary from ground/sea level to up to 20 000 m.

*[Editor’s note: there are two views expressed with regard to length of ADL links: View 1: the maximum length of the ADL links need to be specified/View 2: the maximum length of the ADL links is not needed since the protection criterion is determined through I/N and specification of the maximum link length does not appear to serve a purpose to conduct studies.]*

The ground terminals may be at a permanent location or they may be transportable. Transportable ground terminals can be moved to meet operational needs and the duration of use while it remains at a particular location is dependent upon operational requirements. In certain instances, an aeronautical station may be located, for example, on board ship or on a platform at sea.

*[Editor’s note: It may also be discussed the alignment with terminology of the RR. For example we use different terms for aeronautical stations - ground station, ground terminal, ground terrestrial station; instead of aircraft stations we say airborn etc.]*A single ground terminal may simultaneously support several aircraft stations at the same time via different links.

The application of system 6 is an automated unmanned aerial vehicle (UAV) based wide area ocean surface exploration system used to conduct multiple activities including maritime search and rescue, disaster relief support activities and support to air crash investigations conducted in territorial and international waters. The system consists of multiple UAVs conducting video surveillance of a wide ocean surface area. In order to achieve the required coverage that satisfies large video surveillance footprints, the UAVs form a mesh network to deliver high resolution video to either a ship or land based command and monitoring centers. The received video data is used to identify objects of interest, such as, aircraft debris and distressed personnel. The frequency selection for individual UAVs depends on the number of UAVs participating in a task and their bandwidth requirements. The mesh network can be configured in multiple ways depending on the task requirements, either as a single network or multiple sub-networks assigned with dedicated frequency channels and bandwidths. Following figure depicts the above mentioned application. Table 1 contains the characteristics of the radio systems used for payload communications. It should be noted that Table 1 only depicts radio systems used for payload communications as part of this application and those used for non-payload communications are not indicated in this table. In Table 1 for System 6, Airborne 1 and Airborne 2 represent two UAVs with similar radio system characteristics and are used to identify two ends of a single hop communication link within the mesh network.

Figure 1

**Operation of UAV based wide area ocean surface exploration system**



*[Editor’s note: with regards to operation of mesh networks two views were expressed: View 1 - it needs to be clarified how spectrum is managed in mesh networks (number of channels or one channel, overall spectrum used etc.) that is useful in the studies on agenda item 1.1 ; View 2 – There is no need in collecting information on spectrum management in mesh networks in a sharing studies involving an AMS or MMS receiver because protection criterion is set in terms of I/N and not using wanted carrier ]*

The application of System 7 in Table 1 is earth surface exploration system used to conduct or support activities including maritime search and rescue, disaster relief and rescue in national territories and international [airspace and] waters. Once the visual monitoring results are taken by any aircraft, the captured video is delivered from one aircraft to the other by using 5 MHz aeronautical datalink (ADL) and any audio communication between aircrafts is delivered by using 8 kHz ADL as depicted in Figure 2. The details of technical characteristics are given in Table 1. The center frequency for two ADLs will be selected differently in the tuning range. In Figure 2 two aircrafts are operating in one set. There could be multiple sets.

Figure 2

**Example of configuration of two aeronautical datalinks by System 7**

A screenshot of a video game

Description automatically generated

*[Editor’s note: some of the elements of the description of System 8 can be also reflected in section related to applications]*

The System 8 is planned for use both on national territory and in international airspace and international waters.

The main application of this system:

– exchange of various information, including the transfer of high-speed data, with aircraft and ships performing various commercial and science missions;

– organization of monitoring of linear and area hazardous production facilities and areas.

Direct communication between aircrafts and ships is also possible.

With regard to international waters and international airspace, the use of this system is intended only in local areas for conducting pre-planned research missions, for example, scientific studies of the sea surface or the atmosphere.

The construction of this system is planned on the basis of modern commercially available state-of-art telecommunication equipment.

**3 Technical characteristics of aeronautical mobile systems**

Typical technical characteristics for representative airborne data links for the frequency range 4 400-4 990 MHz are provided in Table 1.

**3.1 Transmitter and receiver characteristics**

The aeronautical mobile systems operating or planned to operate within the frequency range 4 400‑4 990 MHz typically use digital modulations. A given transmitter may be capable of radiating more than one waveform. The out-of-band and spurious emissions of these aeronautical systems are compliant with ITU-R Recommendation SM.1541 (Annex 11) and ITU-R Recommendation SM.329 (Category A), respectively.

**3.2 Antenna characteristics**

A variety of different types of antennas are used by systems in the frequency range 4 400‑4 990 MHz. Antennas in this range 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 antenna gains are typically between +3 dBi and 19 dBi. The ground based antenna gain is typically between 3 dBi and 31 dBi. Horizontal, and vertical polarizations could be used.

Antenna characteristics available in Table 1 should be used for studies unless measured data is available.

**4 Protection criteria**

An increase in receiver effective noise of 1 dB would result in significant degradation in communication range.

Such an increase in effective receiver noise level 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 systems referenced herein from interference due to another radiocommunication service. If multiple potential interference sources are present, protection of the AMS and MMS systems requires that this criterion is not exceeded due to the aggregate interference from the multiple sources.

TABLE 1

**Typical technical characteristics of representative systems operating in the aeronautical mobile service   
in the frequency range 4 400-4 990 MHz**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Units** | **System 1**  **Airborne** | **System 1**  **Ground** | | | **System 2**  **Airborne** | **System 2**  **Ground** | | |
| Transmitter | | | | | | | | | |
| Tuning range | MHz | 4 400-4 990(1) | 4 400-4 990(1) | | | 4 400-4 990(1) | 4 400-4 990(1) | | |
| Power output | dBm | 45 | 45 | | | 35-39 | 30-39 | | |
| Bandwidth (3 dB) | MHz | 1 | 1 | | | 6 / 10 / 20 | 6 / 10 / 20 | | |
| **Receiver** | | | | | | | | | |
| Tuning range | MHz | 4 400-4 990(1) | 4 400-4 990(1) | | | 4 400-4 990(1) | 4 400-4 990(1) | | |
| Selectivity (3 dB) | MHz | 1 | 1 | | | 6 / 10 / 20 | 6 / 10 / 20 | | |
| Noise figure | dB | 3.5 | 3 | | | 3.5 | 3 | | |
| Thermal noise level | dBm | −110.5 | −111 | | | −102.5 to −97.5 | −103 to −98 | | |
| **Antenna** | | | | | | | | | |
| Antenna type |  | Omnidirectional | Omni-directional | Directional | | Omnidirectional | Omni-directional | Directional | |
| Antenna gain | dBi | 3 | 3 | 19 | 31 | 3 | 6 | 19 | 31 |
| 1st sidelobe | dBi | N/A(2) | N/A(2) | 6 | 11 | N/A(2) | N/A(2) | 6 | 11 |
| Polarization |  | Vertical | Vertical | Vertical | | Vertical | Vertical | Vertical | |
| Antenna pattern |  | N/A(2) | N/A(2) | Uniform distribution(3) | | N/A(2) | N/A(2) | Uniform distribution(3) | |
| Horizontal beamwidth | Degrees | 360 | 360 | 16 | 3.3 | 360 | 360 | 16 | 3.3 |
| Vertical beamwidth | Degrees | 90 | 90 | 16 | 3.3 | 90 | 90 | 16 | 3.3 |

TABLE 1 (*Continued*)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Units** | **System 3**  **Airborne** | | **System 3**  **Ground [and shipborne]** | | **System 4**  **Airborne** | | **System 4**  **Ground** | |
| Transmitter | | | | | | | | | |
| Tuning range | MHz | 4 400-4 940(1) | | 4 400-4 940(1) | | 4 400-4 940(1) | | 4 400-4 940(1) | |
| Power output | dBm | 42-50 | | 42 | | 43 | | 37 | |
| Bandwidth (3 dB) | MHz | 0.158 / 0.97 / 1.23 / 4.0 | | 0.158 / 0.97 / 1.23 / 4.0 | | 0.158 / 2.4 / 4.8 / 9.6 | | 0.158 / 2.4 / 4.8 / 9.6 | |
| **Receiver** | | | | | | | | | |
| Tuning range | MHz | 4 400-4 940(1) | | 4 400-4 940(1) | | 4 400-4 940(1) | | 4 400-4 940(1) | |
| Selectivity (3 dB) | MHz | 0.2 / 1 / 1.5 / 4.5 | | 0.2 / 1 / 1.5 / 4.5 | | 0.2 / 2.6 / 5.0 / 10 | | 0.2 / 2.6 / 5.0 / 10 | |
| Noise figure | dB | 2.5 | | 2.5 (ground) / [6 (shipborne)] | | 2.5 | | 3 | |
| Thermal noise level | dBm | −118.5 to −105.0 | | −118.5 to −105.0 | | −118.5 to −101.5 | | −118 to −101 | |
| **Antenna** | | | | | | | | | |
| Antenna type |  | Omni-directional | Directional | Omni-directional | Directional | Omni-directional | Directional | Omni-directional | Directional |
| Antenna gain | dBi | 3.5 | 16 | 3 | 30 | 4.5 | 16 | 4 | 30 |
| 1st sidelobe | dBi | N/A(2) | 9 | N/A(2) | 17 | N/A(2) | 9 | N/A(2) | 17 |
| Polarization |  | Vertical | Vertical | Vertical | Vertical | Vertical | Vertical | Vertical | Vertical |
| Antenna pattern |  | N/A(2) | Uniform distribution(3) | N/A(2) | Uniform distribution(3) | N/A(2) | Uniform distribution(3) | N/A(2) | Uniform distribution(3) |
| Horizontal beamwidth | degrees | 360 | 33 | 360 | 4.4 | 360 | 33 | 360 | 4.4 |
| Vertical beamwidth | degrees | 35 | 33 | 40 | 4.4 | 35 | 33 | 60 | 4.4 |

TABLE 1 (*Continued*)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Units** | **System 5**  **Airborne** | | **System 5**  **Ground [and shipborne]** | | |
| Transmitter | | | | | | |
| Tuning range | MHz | 4 400-4 990(1) | | 4 400-4 990(1) | | |
| Power output | dBm | 45 | | 45 | | |
| Bandwidth (3 dB) | MHz | 0.4 / 3 / 8.5 | | 0.4 / 3 / 8.5 | | |
| **Receiver** | | | | | | |
| Tuning range | MHz | 4 400-4 990(1) | | 4 400-4 990(1) | | |
| Selectivity (3 dB) | MHz | 0.4 / 3 / 17 | | 0.4 / 3 / 17 | | |
| Noise figure | dB | 3.5 | | 3.5 (ground) / [6 (shipborne)] | | |
| Thermal noise level | dBm | −118.5 to −105.0 | | −118.5 to −105.0 | | |
| **Antenna** | | | | | | |
| Antenna type |  | Omni-directional | Directional | Omni-directional | Directional | |
| Antenna gain | dBi | 3 | 19 | 3 | 19 | 31 |
| 1st sidelobe | dBi | N/A(2) | 6 | N/A(2) | 6 | 11 |
| Polarization |  | Vertical | Vertical | Vertical | Vertical | |
| Antenna pattern |  | N/A(2) | see equation in (4) | N/A(2) | [see equation in (4) (5) /Uniform distribution(3) ] | |
| Horizontal beamwidth | degrees | 360 | 16 | 360 | 16 | 3.3 |
| Vertical beamwidth | degrees | 90 | 16 | 360 | 16 | 3.3 |
| Notes:  (1) RR No. **5.442** applies.  (2) N/A – Not applicable.  (3) Refer to Recommendation ITU-R M.1851.  (4) For antenna gain 19 dBi: and otherwise. Here, (x in radians) and .  (5) For antenna gain 31 dBi: Gψ= 20.log10𝑠𝑖𝑛𝑐15.5𝜋sin𝜓+31.0 ∀ψ∈−64.25°,64.25° and otherwise. Here, (x in radians) and .  *[Editor’s note: the need of this equation should be confirmed. One possible solution is to keep using footnote (3) in case of uniform distribution]*  In the Table “-“ means range of values, and “/” means discrete values.  *[Editor’s note: the noise figure in some parts of Table 1 needs to be further clarified]* | | | | | | |

TABLE 1 (*Continued*)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Units** | **System 6**  **Airborne 1** | **System 6**  **Airborne 2** | **System 6**  **Ship borne** | | **System 6**  **Ground** | |
| Transmitter | | | | | | | |
| Tuning range | MHz | 4 800-4 990 | 4 800-4 990 | 4 800-4 990 | | 4 800-4 990 | |
| Power output | dBm | 27-33 | 27-33 | 35 | | 35 | |
| Bandwidth (3 dB) | MHz | 5/10/20/40 (software configurable) | 5/10/20/40 (software configurable) | 5/10/20/40 (software configurable) | | 5/10/20/40 (software configurable) | |
| Receiver | | | | | | | |
| Tuning range | MHz | 4 800-4 990 | 4800-4 990 | 4 800-4 990 | | 4 800-4 990 | |
| Selectivity (3 dB) | MHz | 5/10/20/40 | 5/10/20/40 | 5/10/20/40 | | 5/10/20/40 | |
| Noise figure | dB | 6 | 6 | 6 | | 4 | |
| Thermal noise level | dBm | −101 to -92 | −101 to -92 | −103 to −94 | | −103 to −94 | |
| Antenna | | | | | | | |
| Antenna type |  | Omnidirectional | Omnidirectional | Omni-directional | Directional | Omni-directional | Directional |
| Antenna gain | dBi | 4.7 | 4.7 | 6 | 11.8 | 6 | 11.8 |
| 1st sidelobe | dBi | N/A | N/A | N/A | Note 2 | N/A | Note 2 |
| Polarization |  | Vertical | Vertical | Vertical | Vertical | Vertical | Vertical |
| Antenna pattern |  | N/A | N/A | Note 1 | Note 2 | Note 1 | Note 2 |
| Horizontal beamwidth | Degrees | 360 | 360 | 360 | 30 | 360 | 30 |
| Vertical beamwidth | Degrees | 90 | 90 | 28 | 18 | 28 | 18 |

TABLE 1 (*Continued*)

| **Parameter** | **Units** | **System 7**  **Airborne 1** | **System 7**  **Airborne 2** |
| --- | --- | --- | --- |
| Transmitter | | | |
| Tuning range | MHz | 4 400-4 990 | 4 400-4 990 |
| Power output | dBm | 30-43 | 30-43 |
| Bandwidth (3 dB) | MHz | 5 / 0.008 | 5 / 0.008 |
| Receiver | | | |
| Tuning range | MHz | 4 400-4 990 | 4 400-4 990 |
| Selectivity (3 dB) | MHz | 5 / 0.008 | 5 / 0.008 |
| Noise figure | dB | [6] | 6 |
| Thermal noise level | dBm | -103 / −131 | -103/ −131 |
| Antenna | | | |
| Antenna type |  | Directional | Directional |
| Antenna gain | dBi | 14 | 14 |
| 1st sidelobe | dBi | -1 | -1 |
| Polarization |  | Vertical | Vertical |
| Antenna pattern |  | Uniform distribution  (Refer to Rec. ITU-R M.1851) | Uniform distribution  (Refer to Rec. ITU-R M.1851) |
| Horizontal beamwidth | Degrees | 24 | 28 |
| Vertical beamwidth | Degrees | 24 | 28 |

TABLE 1 *(End)*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Units** | **System 8**  **Airborne** | **System 8**  **Ground** | **System 8**  **Shipborne** |
| **Transmitter** | | | | |
| Tuning range | MHz | 4 800-4 990 | 4 800-4 990 | 4 800-4 990 |
| Power output | dBm | 26 | 46 | 46 |
| Bandwidth (3 dB) | MHz | 40/50/60/80/100  (software configurable) | 40/50/60/80/100  (software configurable) | 40/50/60/80/100  (software configurable) |
| **Receiver** | | | | |
| Tuning range | MHz | 4 800-4 990 | 4 800-4 990 | 4 800-4 990 |
| Selectivity (3 dB) | MHz | 40/50/60/80/100 | 40/50/60/80/100 | 40/50/60/80/100 |
| Noise figure | dB | 9 | 5 | 5 |
| Thermal noise level | dBm | −89 … -85 | −93 … -89 | −93 … -89 |
| **Antenna** | | | | |
| Antenna type |  | Omnidirectional | Directional (steerable, MIMO) | Directional (steerable, MIMO) |
| Antenna gain | dBi | 0 | 15 | 15 |
| 1st sidelobe | dBi | N/A | N/A | N/A |
| Polarization |  | Vertical | Vertical | Vertical |
| Antenna pattern |  | N/A | Rec ITU-R F.1336 | Rec ITU-R F.1336 |
| Horizontal beamwidth | Degrees | 360 | 65 | 65 |
| Vertical beamwidth | Degrees | 90 | 90 | 90 |

**Annex 2  
  
Technical characteristics and protection criteria for systems operating in the maritime mobile service**

**1 Introduction**

[Systems and networks operating in the MMS are used for broadband data-links to support various applications such as remote sensing, e.g. earth sciences, land management, energy distribution.

These maritime mobile systems may operate on a 24/7 basis to support security, law enforcement, humanitarian assistance efforts and search and rescue.]

**2 Operational deployment**

System 1 listed in Table 2 uses maritime mobile service data links (MDL) to create a mesh network radio system between ship stations and ground stations to transfer data between nodes. These transmissions could include ship-to-ship, ship-to-coast, or coast-to-ship datalinks. This system can be deployed near a coast or out in international waters. The usage of this system supports several operations, such as maritime search and rescue, disaster relief, and surveillance. This radio system is installed on ship stations and ground stations along the coast to allow for datalinks required to transfer data such as imaging and video amongst the users of this mesh network. The mesh network allows for the ships to communicate with other vessels both near port and out in open waters with enough bandwidth capacity to facilitate multiple users over large areas. The links utilized are expected to only extend to radio-line of sight, however there may be multiple nodes in the mesh network and the deployment is expected to cover an area larger (e.g. line-of-sight link) than any one individual desired link.

*[Note: in this section certain points should be considered further:*

*▪ the tasks to be performed by MMS systems for all systems;*

*▪ the geographical area of use for systems*

*• The time utilization factors for the operations of the MMS systems.*

*▪ the planned usage of the 4 800-4 990 MHz band (spectrum required, possibility of using only the selected parts of the 4 800-4 990 MHz band, frequency hopping and selection of the working channel, including moving to another band, e.g. 4 400-4 800 MHz, etc.);]*

**3 Technical characteristics of systems operating in the maritime mobile service**

Typical technical characteristics for representative maritime data links for the frequency range 4 400-4 990 MHz are provided in Table 2.

**3.1 Transmitter and receiver characteristics**

The maritime mobile systems operating or planned to operate within the frequency range 4 400‑4 990 MHz typically use digital modulations. A given transmitter may be capable of radiating more than one waveform. The out-of-band and spurious emissions of these maritime systems are compliant with ITU-R Recommendation SM.1541 (Annex 11) and ITU-R Recommendation SM.329 (Category A), respectively.

**3.2 Antenna characteristics**

The maritime mobile systems listed in Table 2 may use a variety of types of antennas that can be installed on either the ship station or ground station. These antenna gains are typically between 2.5 and 15 dBi.

**4 Protection criteria**

An increase in receiver effective noise of 1 dB would result in significant degradation in communication range.

Such an increase in effective receiver noise level 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 MMS systems referenced herein from interference due to another radiocommunication service. If multiple potential interference sources are present, protection of the MMS systems requires that this criterion is not exceeded due to the aggregate interference from the multiple sources.

TABLE 2

**Typical technical characteristics of representative systems operating in the maritime mobile service   
in the frequency range 4 400-4 990 MHz**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Units** | **System 1**  **Shipborne** | | | **System 1**  **Ground** | | | **System 2**  **Shipborne** | **System 2**  **Ground** |
| Transmitter | | | | | | | | | |
| Tuning range | MHz | 4 400-4 940 | | | 4 400-4 940 | | | 4 800-4 990 | 4 800-4 990 |
| Power output | dBm | 39 | | | 39 | | | 46 | 46 |
| Bandwidth (3 dB) | MHz | 5.6/11.3/22.6 | | | 5.6/11.3/22.6 | | | 40/50/60/80/100  (software configurable) | 40/50/60/80/100  (software configurable) |
| Receiver | | | | | | | | | |
| Tuning range | MHz | 4 400-4 940 | | | 4 400-4 940 | | | 4 800-4 990 | 4 800-4 990 |
| Selectivity (3 dB) | MHz | 5.6/11.3/22.6 | | | 5.6/11.3/22.6 | | | 40/50/60/80/100 | 40/50/60/80/100 |
| Noise figure | dB | 6 | | | 6 | | | 5 | 5 |
| Thermal noise level | dBm | -100.5 to -94.5 | | | -100.5 to -94.5 | | | −93 … -89 | −93 … -89 |
| Antenna | | | | | | | | | |
| Antenna type |  | Omnidirectional | | | Omni-directional | | | Directional (steerable, MIMO) | Directional (steerable, MIMO) |
| Antenna gain | dBi | 6 | 4.2 | 2.5 | 6 | 4.2 | 2.5 | 15 | 15 |
| 1st sidelobe | dBi | N/A(1) | | | N/A(1) | | | N/A(1) | N/A(1) |
| Polarization |  | Vertical | | | Vertical | | | Vertical | Vertical |
| Antenna pattern |  | N/A(1) | | | N/A(1) | | | Rec ITU-R F.1336 | Rec ITU-R F.1336 |
| Horizontal beamwidth | Degrees | 360 | | | 360 | | | 65 | 65 |
| Vertical beamwidth | Degrees | 30 | 37 | 69 | 30 | 37 | 69 | 90 | 90 |
| Notes:  (1) N/A – Not applicable. | | | | | | | | | |