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| **US Radiocommunication Sector****FACT SHEET** |
| **Working Party:** ITU-R WP 5B | **Document No:** USWP5B-28/XX |
| **Reference:** 5B/481 Annex 23 | **Date:** 18 January 2022 |
| **Document Title:** Working Document Towards a Preliminary Draft Revision of 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”** |
| **Author(s)/Contributor(s):**Fumie WingoDON CIOTaylor KingACES for DON CIO Carmelo RiveraACES for DON CIOJerry UlcekUS Coast GuardKen Keane Duane MorrisDan Jablonski JHU APLThomas O’BrienDoD TRMC | Phone: 571-521-9295Email: fumie.wingo@navy.mil Phone: 443-966-0550Email: taylor.king@aces-inc.com Phone: 240-586-4028Email: carmelo.rivera@aces-inc.com Phone: 202-579-5924Email: jerry.l.ulcek@uscg.milPhone: 703-966-2268Email: kkeane@duanemorris.comPhone: 301-335-6192Email: dan.jablonski@jhuapl.eduPhone: 571-372-2752Email: Thomas.o.obrien2.civ@mail.mil |
| **Purpose/Objective:** The purpose of this document is to continue the revision to Recommendation ITU-R M.2116-0 |
| **Abstract:** Recommendation ITU-R M.2116-0 contains characteristics for the aeronautical mobile service systems operating within the 4400-4990 MHz frequency range. This contribution seeks to address comments and editor’s notes provided at the previous meeting. |
| **Fact Sheet Preparer:** Taylor King/ Dan Jablonski |

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| 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 previous meeting of Working Party 5B (e-meeting, December 2021) the meeting discussed several input contributions and made progress on 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. The proposed edits are highlighted in yellow.

**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 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 it is necessary to further review this document at future meetings of WP5B with a view to inter alia reconcile the Views expressed as well as addressing the concerns expressed in editor's note in the document.]*

**Scope**

This Recommendation provides information on the technical and operational 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.

**Keywords**

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

**Abbreviations/Glossary**

AMDL Aeronautical mobile data link

AMS Aeronautical mobile service

MDL Maritime mobile service data link

MMS Maritime mobile service

RR : Radio regulation

UAV: Unmanned aerial vehicle

**Related ITU-R Recommendations and Reports**

*Recommendation:*

[ITU-R SM.329](https://www.itu.int/rec/R-REC-SM.329/en) Unwanted emissions in the spurious domain

[ITU-R M.1851](https://www.itu.int/rec/R-REC-M.1851/en) Mathematical models for radiodetermination radar systems antenna patterns for use in interference analyses

*Report:*

[ITU-R M.2119](https://www.itu.int/rec/R-REC-SM.329/en) Sharing between aeronautical mobile telemetry systems for flight testing and other systems operating in the 4 400-4 940 and 5 925-6 700 MHz bands and 5 925-6 700 MHz bands

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 or ship to aircraft links to support various applications, such as remote sensing for earth sciences, land management, and 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, such as remote sensing for earth sciences, land management, and energy distribution;

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

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 radio regulation (RR) No. **5.442** provides some restrictions for the use of AMS in parts of the frequency band;

*d)* that AMS systems in the 4 400-4 990 MHz band are not standardised by ICAO;

*e)* that the frequency band 4 400-4 990 MHz is not considered for distress and safety communications for the global maritime distress and safety system in accordance with the Radio Regulations,

*f)* That the use of the AMS and MMS in the 4 400-4 990 MHzdoes not preclude the use of this frequency band by any current and planned application of the services to which it is allocated and does not establish any priority in the Radio Regulations;

*recommends*

**1** that the technical and operational 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 and operational 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**

**1 Introduction**

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

These aeronautical mobile system (uplink, downlink and air-air) operations support security, law enforcement, and humanitarian assistance efforts throughout the 4 400‑4 990 MHz frequency range or portions thereof. Given the unpredictable nature of these tasks, immediate operations can be required at any time, and advanced planning is not possible. Additionally, some operations can also take place in international airspace and waters/outside national borders (e.g. to fight against piracy, to escort ships, for deep sea rescue, for search and rescue/emergency operations at sea, etc). It can be single link involving AMS (and/or MMS) stations or a mesh networks involving several AMS stations (and/or MMS) stations.

*[Editor’s Note: the section needs to be specified taking into account the actual use of AMS, including use in international airspace. It should also be reflected that AMS is not safety service in this band]*

**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 section Introduction 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 4 400-4 990 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” international airspace and waters for their potential operation, 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 AMDL 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 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 (AMDL) are operated between aeronautical stations and aircraft stations, between aircraft stations equipped or between aircraft stations and ship stations with AMDL and can be deployed anywhere within countries whose administration has authorized their use or in international airspace. The stations in international airspace are only authorized by the administration of the flag state of the aircraft and/or ship.

*[Editor’s note: Since “International airspace” does not have definition in RR. We can consider using the construction “outside of national borders” in the Recommendation]*

Some of these operations in the international aerospace can be planned in advance, whereas some other operations may take place in unpredictable time and location.

*[Editor’s note: further clarification of this paragraph can be provided for the term “unpredictable time and location”.]*

AMDL 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 may vary greatly. The operational altitude of airborne platforms equipped with these AMDLs can vary from ground/sea level to 20 000 m.

*[Editor’s note: it should be clarified if the AMS systems operates at the typical heights or the heights vary all the time including the case of air-to-air links]*

*[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 they remain 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.

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 are 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. Figure 1 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 unmanned aerial vehicles 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]*

 *[Editor’s note: in the methodology considered within WP 5D, the assessed interference is to a AMS or MMS station independently it is a part of mesh networks or a single station.]*

*[Editor’s note: it should be clarified the UAVs’ density and the heights they operate at]*

The application of System 7 in Table 1 is earth surface exploration operating in national territories and international airspace to conduct or support activities including maritime search and rescue, disaster relief and rescue in national territories and international 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 AMDL and any audio communication between aircrafts is delivered by using 8 kHz AMDL as depicted in Figure 2. The details of technical characteristics are given in Table 1. The center frequency for two AMDLs will be selected 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**



The System 8 is designed to be used 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 to conduct planned research missions in local areas, 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 Recommendation ITU-R SM.1541 (Annex 11) and Recommendation ITU-R SM.329 (Category A), respectively. These systems typically place a first stage very low noise amplifier (LNA) directly at the terminals of the receiver antenna as well as additional amplifiers or low attenuation cables. Therefore, for the purpose of link budget calculations, cable feeder loss for these systems can be assumed to be 0 dB.

**3.2 Antenna characteristics**

A variety of different types of antennas is used by systems in the frequency range 4 400‑4 990 MHz. Antennas in this range generally differ in size 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 the Table 1 should be used for studies unless measured data is available.

The shipborne antenna height as described for Systems 3 5, 6, and 8 in Table 1 is in the range of 10 to 30 metres.

**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/application]. If multiple potential interference sources are present, protection of the AMS 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**

***[Editor’s note: there is still some square brackets around some parameters in the table. It needs to be further checked and confirmed]***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **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 5Ground [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 | −114.5 to −98 | −114.5 to −98 |
| 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 6Airborne 1** | **System 6Airborne 2** | **System 6Ship borne** | **System 6Ground** |
| **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 7Airborne 1** | **System 7Airborne 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 8Airborne** | **System 8Ground** | **System 8Shipborne** |
| **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 for earth sciences, land management, and energy distribution.

These maritime mobile systems may operations support security, law enforcement, humanitarian assistance efforts and search and rescue throughout the 4 400‑4 990 MHz frequency range or portions thereof in their own territories. Given the unpredictable nature of these tasks, immediate operations can be required at any time, and advanced planning is not possible. Additionally, some operations can also take place in international airspace and waters (e.g. to fight against piracy to escort ships, for deep sea rescue, for search and rescue/emergency operations at sea, etc). It can be single link involving (AMS and/or) MMS stations or a mesh networks involving several (AMS stations and/or) MMS stations.

**2 Operational deployment**

[System 1 /The maritime mobile systems] listed in Table 2 uses maritime mobile service data links to create a network 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 stations in international waters are only authorized by the administration of the flag state of ship.

The usage of this system supports several operations, such as maritime search and rescue, disaster relief, and surveillance. [This radio system is / These radio systems] are 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 extend to radio-line of sight only, however there may be multiple nodes and if the mesh network is used the deployment may cover an area larger (e.g. line-of-sight link) than any one individual desired link.

Some of these operations in the international waters can be planned in advance, whereas some other operations may take place in unpredictable time and location.

*[Editor’s note: further clarification of this paragraph can be provided for the term “unpredictable time and location”.]*

*[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 Recommendation ITU-R SM.1541 (Annex 11) and Recommendation ITU-R SM.329 (Category A), respectively. These systems typically place a first stage very low noise amplifier (LNA) directly at the terminals of the receiver antenna as well as additional amplifiers or low attenuation cables. Therefore, for the purpose of link budget calculations, cable feeder loss for these systems can be assumed to be 0 dB.

**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.

The shipborne antenna height as described in Table 2 is in the range of 10 to 30 metres.

**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/application]. 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 1Shipborne** | **System 1Ground** | **System 2Shipborne** | **System 2Ground** |
| **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. |