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| **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”** |
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| **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.  |

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| Working document towards 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** |

The United States proposes that ITU-R Working Party (WP) 5B consider the following edits to the working document towards a preliminary draft revision to Recommendation ITU-R M.2116-0 which are contained in Attachment 1. The proposed edits are highlighted in grey.

**Attachment:** 1

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| ATTACHMENT  |
| WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT REVISION OF RECOMMENDATION ITU-R M.2116-0 |

Summary of revision

The revision provides some updates of characteristics of systems contained in the previous version as well as characteristics of new systems operated in the aeronautical mobile service and adds an annex for the characteristics of systems operated in the maritime mobile service. It also refines the operational description of the systems.

(2018-202X)

[Editor’s Note: This compilation document is merged between document 5B/279 and 5B/296]

Scope

This Recommendation provides information on the technical and operational characteristics and protection criteria for systems operating in the aeronautical and maritime mobile services planned to or currently operating within the frequency range 4 400-4 990 MHz for use in sharing and compatibility studies as needed and address aeronautical mobile telemetry systems.

Keywords

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

Abbreviations/Glossary

AMDL: Aeronautical mobile data link

AMS Aeronautical mobile service

AMT: Aeronautical mobile telemetry

MDL: Maritime mobile service data link

MMS: Maritime mobile service

RR: Radio Regulations

UAV: Unmanned aerial vehicle

Related ITU-R Recommendations and Reports

Recommendations

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

ITU-R [SM.1541](https://www.itu.int/rec/R-REC-SM.1541/en): *Unwanted emissions in the out-of-band 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) use broadband data-links including aircraft links to/from the ground, to other aircraft, or, in certain instances to/from ships to support various applications such as remote sensing, for example earth sciences, energy distribution system monitoring and support security, law enforcement and humanitarian assistance efforts;

*b)* that systems and networks operating in the maritime mobile service (MMS) use broadband maritime data-links to support various applications, such as remote sensing for earth sciences, energy distribution systems monitoring security, law enforcement and humanitarian assistance efforts;

*c)* that systems and networks operating in the AMS and MMS also use narrow-band 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 in all three ITU regions;

*c)* that the Radio Regulations (RR) No. **5.442** provides restrictions on the use of AMS in the frequency bands 4 825-4 835 MHz and 4 950-4 990 MHz;

*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 RR;

*g)* that regulatory provisions relevant for AMS and MMS are contained in Chapter **VIII** and Chapter **IX** (e.g. Articles **43** and **51**) of the RR respectively;

*h)* that the AMS and MMS systems contained in the present Recommendation are not considered as safety-of-life systems,

recommends

1 that the technical and operational characteristics and protection criteria for systems operating in the AMS given in the Annex 1 should be considered when performing sharing and compatibility analyses;

2 that the technical and operational characteristics and protection criteria for systems operating in the MMS given in the Annex 2 should be considered when performing sharing and compatibility analyses;

3 that the following Notes are considered as part of this Recommendation.

NOTE 1 – The characteristics and protection criteria should not have any adverse effect to Appendix **30B** of the RR.

NOTE 2 – While this Recommendation addresses AMS generally, characteristics for Systems 2 and 5 (in Annex 1) may be considered representative of AMT systems in the band 4 400-4 990 MHz. AMT transmissions are limited to aircraft stations, therefore only aircraft transmitter characteristics of Systems 2 and 5 are representative for AMT systems. Receiver characteristics of System 2 from Table 1 (in Annex 1) are representative of characteristics for AMT airborne relay and ground receivers, and the receiver characteristics of System 5 from Table 1 (in Annex 1) are representative of characteristics for AMT shipborne receivers. Resolution **416 (Rev.WRC-07)** addresses operational requirements for AMT systems only (not AMS in general) in the frequency band 4 400-4 990 MHz.

Annex 1

Technical and operational characteristics and protection criteria for systems operating in the aeronautical mobile service

# 1 Introduction

Systems and networks operating in the AMS use broadband data-links including aircraft to aircraft to support various applications, such as remote sensing for example earth sciences, and energy distribution system monitoring.

These aeronautical mobile systems operating throughout the 4 400‑4 990 MHz frequency range or portions thereof may also be used to support security, law enforcement, and humanitarian assistance efforts. Sometimes these tasks are of unpredictable nature and immediate operations can be required at any time. However, some operations can be planned in advance, for which coordinated use with relevant national authorities is possible.

# 2 Operational deployment

Aeronautical mobile data links (AMDL) are operated between aeronautical stations and aircraft stations, aircraft stations or aircraft stations and ship stations equipped with AMDL and can be deployed within the national territory of a country whose administration has authorized their use.

Additionally, some operations (e.g., to fight against piracy, to escort ships, for deep sea rescue, for search and rescue/emergency operations at sea, etc) can also take place in areas that are outside the territory under the jurisdiction of any ITU Member State.

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[USA note: The United States supports option 1.]

AMDL includes transmission from and to, either aircraft stations or 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. The operational altitude of aircraft equipped with these AMDLs can vary from ground/sea level to 20 000 m.

In case of using directional antennas, the direction of the airborne antenna’s main lobe when communicating with its aeronautical station normally points away from the territory if the aeronautical station is located away from the territory of another coastal state. In certain instances the direction of the airborne antenna’s main lobe can point in the direction of the territory of another coastal state if the aeronautical station is between the aircraft and this territory (e.g., when aeronautical station is located on board ship).

The ground terminals (aeronautical stations) may be either at a permanent location or transportable. Transportable ground terminals can be moved to meet operational needs and the duration of use while the length of time 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 via different links.

The application of system 6 is on-board aircraft for 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 national territories and areas that are outside the territory under the jurisdiction of any ITU Member State. The system consists of multiple aircraft conducting video surveillance of a wide ocean surface area. In order to achieve the required coverage that satisfies large video surveillance footprints, the aircraft are part of a mesh network to deliver high resolution video to either a ship or land-based command and monitoring centres. The received video data are used to identify objects of interest, such as, aircraft debris and distressed personnel. Between 10 and 20 aircraft (e.g. Systems 1 and 2 in Table 1) could be expected to participate in a task.

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 system and its application. Table 1 contains the characteristics of these radio systems used for payload communications. In Table 1 for System 6, Airborne 1 and Airborne 2 represent two aircraft 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 airborne for wide area ocean surface exploration system

The application of System 7 in Table 1 is earth surface exploration operating on national territories and areas that are outside the territory under the jurisdiction of any ITU Member State to conduct or support activities including maritime search and rescue, disaster relief and rescue in such areas. 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 Fig. 2. The details of technical characteristics are given in Table 1.

The centre frequency for two AMDLs will be selected in the tuning range. In Fig. 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



System 8 is designed to be used both on national territory and areas that are outside the territory under the jurisdiction of any ITU Member State,

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 aircraft and ships is also possible.

With regard to the areas that are outside the territory under the jurisdiction of any ITU Member State, 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.

# 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.

## 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 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.

# 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 or another application in the mobile service. 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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Parameter | Units | System 1Airborne | System 1Ground and shipborne | System 2Airborne | System 2Ground |
| **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**(4) |
| 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 3Airborne | System 3Ground and shipborne | System 4Airborne  | System 4Ground |
| **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**(4) |
| Antenna type |  | Omni-directional | Directional | Omni-directional | Directional | Omni-directional | Directional | Omni-directional | Directional |
| Antenna gain  | dBi | 3.5 | 16 | 3 | 6 | 15 | 30 | 4.5 | 16 | 4 | 30 |
| 1st sidelobe | dBi | N/A(2) | 9 | N/A(2) | 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 | 30 | 4.4 | 360 | 33 | 360 | 4.4 |
| Vertical beamwidth  | Degrees | 35 | 33 | 40 | 30 | 30 | 4.4 | 35 | 33 | 60 | 4.4 |

TABLE 1 (*continued*)

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Units | System 5Airborne | 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**(4) |
| 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 (5) | N/A(2) |  See equations (5) & (6) |
| Horizontal beamwidth | Degrees | 360 | 16 | 360 | 16 | 3.3 |
| Vertical beamwidth | Degrees | 90 | 16 | 360 | 16 | 3.3 |

TABLE 1 (*continued*)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | System 6Airborne 1/ Airborne 2 | System 6Ship borne | System 6Ground |
| Transmitter |
| Tuning range | MHz | 4 400-4 990 | 4 400-4 990 | 4 400-4 990 |
| Power output | dBm | 27-42 | 35 | 35-42 |
| Bandwidth (3 dB) | MHz | 5 / 10 / 20 / 40 (software configurable) | 5 / 10 / 20 / 40 (software configurable) | 5 / 10 / 20 / 40 (software configurable) |
| Receiver(4) |
| Tuning range | MHz | 4 400-4 990 | 4 400-4 990 | 4 400-4 990 |
| Selectivity (3 dB) | MHz | 5 / 10 / 20 / 40 | 5 / 10 / 20 / 40 | 5 / 10 / 20 / 40 |
| Noise figure | dB | 6 | 4 | 4 |
| Thermal noise level | dBm | −101 to −92 | −103 to −94 | −103 to −94 |
| Antenna(4) |
| Antenna type |  | Omnidirectional | Omni-directional | Directional | Omni-directional | Directional |
| Antenna gain | dBi | 4.7 | 6 | 11.8 | 6 | 11.8 |
| 1st sidelobe | dBi | N/A | N/A | Note 2 | N/A | Note 2 |
| Polarization |  | Vertical | Vertical | Vertical | Vertical | Vertical |
| Antenna pattern |  | N/A | Note 1 | Note 2 | Note 1 | Note 2 |
| Horizontal beamwidth | Degrees | 360 | 360 | 30 | 360 | 30 |
| Vertical beamwidth | Degrees | 90 | 28 | 18 | 28 | 18 |

TABLE 1 (*continued*)

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

TABLE 1 *(end)*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Units | System 8Airborne | System 8Ground | System 8Shipborne |
| Transmitter |
| Tuning range | MHz | 4 400-4 990 | 4 400-4 990 | 4 400-4 990 |
| 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(4) |
| Tuning range | MHz | 4 400-4 990 | 4 400-4 990 | 4 400-4 990 |
| 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(4) |
| 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 |
| Notes:(1) RR No. **5.442** applies.(2) N/A – Not applicable.(3) Refer to Recommendation ITU-R M.1851.(4) A typical value of the feeder loss associated with these systems can range from 0-3 dB with 2 dB as the representative value.(5) For antenna gain 19 dBi: and otherwise. Here, (x in radians) and . (6) For antenna gain 31 dBi: and otherwise. Here, (x in radians) and .In the Table “-” means range of values, and “/” means discrete values. |

Annex 2

Technical and operational characteristics and protection criteria for systems operating in the maritime mobile service

# 1 Introduction

Systems and networks operating in the MMS use broadband data-links to support various applications, such as remote sensing for earth sciences, and energy distribution system monitoring.

These maritime mobile systems operating throughout the 4 400‑4 990 MHz frequency range or portions thereof may also be used to support security, law enforcement, and humanitarian assistance efforts. Sometimes these tasks are of unpredictable nature and immediate operations can be required at any time, however some of these operations can be planned in advance, for which coordinated use with relevant national authorities is possible.

Additionally, some operations (e.g., to fight against piracy deep sea rescue, for search and rescue/emergency operations at sea, etc) can also take place in the areas that are outside the territory under the jurisdiction of any ITU Member State.

# 2 Operational deployment

The maritime mobile systems listed in Table 2 uses maritime mobile service data links to create a network between ship stations and coast 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 the areas that are outside the territory under the jurisdiction of any ITU Member State.

In such areas, MMS stations are only authorized by the administration of the flag state of ship and are not notified to the Bureau or registered in the MIFR.

The usage of these systems supports several operations, such as maritime search and rescue, disaster relief, and surveillance. These radio systems may be based on ship stations and coast stations 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. It can be single link involving MMS stations (between coast stations and ship stations, or between ship stations) or a mesh network involving several MMS stations.

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**[USA note: The United States supports option 1.]**

# 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.

## 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 or another application in the mobile 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 1Shipborne | System 1Ground | System 2Shipborne | System 2Ground |
| **Transmitter** |
| Tuning range | MHz | 4 400-4 940 | 4 400-4 940 | 4 400-4 990 | 4 400-4 990 |
| 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**(2)   |
| Tuning range | MHz | 4 400-4 940 | 4 400-4 940 | 4 400-4 990 | 4 400-4 990 |
| 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**(2)   |
| 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.(2) A typical value of the feeder loss associated with these systems can range from 0-3 dB with 2 dB as the representative value. |