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| **Document Title:** Working Document towards a Preliminary Draft New Recommendation ITU-R M.[ARNS-AMRS 960-1215 MHz], “Characteristics and protection criteria for the aviation systems operating in the aeronautical radionavigation service and the aeronautical mobile (route) service in the frequency band 960-1 215 MHz” |
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| **Purpose/Objective:** The purpose of this contribution is to provide the technical characteristics and protection criteria for the aviation systems operating in the aeronautical radionavigation service (ARNS) and aeronautical mobile (route) service (AM(R)S) in the frequency band 960-1 215 MHz. |
| **Abstract:** This contribution provides the technical characteristics and protection criteria for the aviation systems operating in the aeronautical radionavigation service (ARNS) and aeronautical mobile (route) service (AM(R)S) in the frequency band 960-1 215 MHz. |

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| working document towards a preliminary draft neW recommendation itu-r m. ITU-R M.[ARNS-AMRS 960-1215 MHz]**Characteristics and protection criteria for the aviation systems operating in the aeronautical radionavigation service and the aeronautical mobile (route) service in the frequency band 960-1 215 MHz** |
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**Introduction**

This contribution provides the technical characteristics and protection criteria for characteristics and protection criteria for the aviation systems operating in the aeronautical radionavigation service and the aeronautical mobile (route) service in the frequency band 960-1 215 MHz.

Attachment: 1

ATTACHMENT

working document towards a preliminary draft new recommendation ITU-r m.[ARNS-AMRS 960-1215 MHZ]

**Characteristics and protection criteria for the aviation systems operating in the aeronautical radionavigation service and the aeronautical mobile (route) service in the frequency band 960-1 215 MHz**

(202X)

Scope

This Recommendation provides the technical characteristics and protection criteria for the aviation systems operating in the aeronautical radionavigation service (ARNS) and the aeronautical mobile (route) service (AM(R)S) in the frequency band 960-1 215 MHz. These technical characteristics and protection criteria should be used for sharing and compatibility studies.

Keywords

AM(R)S, ARNS, DME, ADS-B, SSR, UAT, MLAT, ACAS, LDACS

Abbreviations/Glossary

ACAS: Airborne collision avoidance system

ADS-B: Automatic dependent surveillance-broadcast

AM(R)S: Aeronautical mobile (route) service

ARNS: Aeronautical radionavigation service

DME: Distance measuring equipment

LDACS: L-band digital aeronautical communication system

MLAT: Multilateration system

SSR: Secondary surveillance radar

ICAO: International Civil Aviation Organization

Related ITU Recommendations and Reports

Recommendation

[ITU-R SM.1535](https://www.itu.int/rec/R-REC-SM.1535/en) The protection of safety services from unwanted emissions

The ITU Radiocommunication Assembly,

considering

*a)* that aeronautical safety communications are used in all areas that aircraft operate and land, and in all phases of flight;

*b)* TBA,

recognizing

*a)* that the ICAO develops standards and recommended practices for civil aviation;

*b)* that Annex 10 to the Convention on International Civil Aviation contains standards and recommended practices for aeronautical radiocommunication systems used by civil aviation;

*c)* that the ARNS and AM(R)S are safety services;

*d)* that No. **4.10** of Radio Regulations stipulates “Member States recognize that the safety aspects of radionavigation and other safety services require special measures to ensure their freedom from harmful interference; it is necessary therefore to take this factor into account in the assignment and use of frequencies”;

*e)* that Recommendation ITU-R SM.1535 provides a guideline for the protection of safety services from unwanted emissions,

recommends

1 that the technical characteristics of the aviation systems operating in the 960-1 215 MHz frequency band, allocated to the ARNS and AM(R)S, and described in Annex 1, should be considered for sharing and compatibility studies;

2 that the criterion of the interfering signal power at the receiver arising from all sources of radio-frequency emissions from radiocommunication services with a corresponding co-primary frequency allocation to the receiver noise power level, I/N = -10 dB should be used to protect the aviation navigation systems and aviation surveillance systems operating in the 960-1 215 MHz frequency band, allocated to ARNS and AM(R)S, and that this represents the aggregate protection level if multiple interferers are present;

3 that the criterion of the interfering signal power at the receiver arising from all sources of radio-frequency emissions from radiocommunication services with a corresponding co-primary frequency allocation to the receiver noise power level, I/N = -6 dB should be used to protect the aviation communication systems operating in the 960-1 215 MHz frequency band, allocated to AM(R)S, and that this represents the aggregate protection level if multiple interferers are present;

4 that the protection criteria in *recommends* 2 and *recommends* 3 does not include the aviation safety margin. This aviation safety margin is expected if the *I/N* protection criteria of – 6 dB is used in the sharing and compatibility studies;

5 that the total interfering signal power at the receiver from all other radiations and adjacent-band emissions to the receiver noise power level, I/N = -20 dB should be used to protect aviation systems in the 960-1 215 MHz frequency band.

**ANNEX 1**

**A1.1 Background**

The frequency band 960-1 215 MHz is allocated to the aeronautical radionavigation service (ARNS) and the band 960-1 164 MHz is allocated to the aeronautical mobile (route) service (AM(R)S). The frequency band 1 087.7-1 092.3 MHz is allocated to the aeronautical mobile satellite (route) service (AMS(R)S) on a primary basis, limited to the space station reception of Automatic Dependent Surveillance – Broadcast (ADS-B). These allocations are heavily used by aviation safety-of-life systems.

**A1.2 Protection criteria for aviation systems**

Aviation safety-of-life systems required the highest levels of availability, integrity, and continuity. For example, the Category I integrity is 1-1e-7 and Category II/III integrity is 1-1e-9. Such high levels of requirements are achieved by ensuring no harmful interference in extreme propagation anomalies and interference conditions. Hence, a protection criterion of I/N = -10 dB for aviation navigation and surveillance and a protection criterion of I/N = -6 dB for aviation communication systems should be used in sharing and compatibility studies. This represents the aggregate protection level if multiple interferers are present, including adjacent-band interferers. Safety margin assumption is expected to be considered where necessary if the *I/N* protection criteria of – 6 dB is applied in studies.

**A1.2.1 Distance Measuring Equipment (DME)**

DME utilizes channels throughout the frequency band 960-1 215 MHz. An aircraft determines its slant range from the ground-based transponder at the DME station by interrogating the transponder on a frequency channel and receiving a reply from the transponder on a different frequency channel separated by 63 MHz.

For many larger aircraft, navigation applications use multiple DME ground stations for position determination (DME-DME navigation). The slant range provided by DME is also an essential element of the Instrument Landing System (ILS) by augmenting or replacing marker beacons as the check on distance to the runway threshold.

The Performance Based Navigation (PBN) concept specifies aircraft area navigation system performance requirements, defined in terms of accuracy, integrity, continuity and functionality, needed within a particular airspace for precise routing. DME-DME can meet the performance requirements for area navigation (RNAV 1, 2 and 5) and the required navigation performance (Basic RNP 1) as specified in Procedures for Air Navigation Services Air Traffic Management.

Many airport ILS/DME installations have been certified at the highest level of precision approach procedures (Category III (CAT III)) and are authorized to be used for auto-landing operations. For Category I instrument landing systems (ILS), integrity is 1 – 1e-7, for Category II and III landing systems, integrity is 1 – 1e-9. For those systems, continuity is 1 – 2 × 10−6. Such high availability and integrity are achieved by ensuring there is no harmful interference to the various components of the ILS from other systems and extreme propagation anomalies must be taken into account.

DME receiver performance and antenna parameters are in Table A1-1.

Table A1-1

**DME receiver performance and antenna parameters**

| **Parameters** | **DME ground** | **DME airborne** |
| --- | --- | --- |
| Frequency range of assignable channels, MHz | 1 025-1 150 | 9 62-1 213 |
| Bandwidth, MHz | 3.5 | 3.5 |
| Maximum antenna gain, dBi  | 16 12 | 5.4 |
| Noise figure, dB | 4 | 4 |
| Cable loss, dB  | < 2 | 4 |
| Selectivity, attenuation (dB) @ freq offset (MHz) | 0 @ 010 @ 2.260 @ 9.6 | 6 @ 0.920 @ 1.0540 @ 1.360 @ 1.570 @ 3 |

**A1.2.2 Secondary Surveillance Radar (SSR)**

SSR systems interrogate an aircraft transponder on 1 030 MHz and receive replies from the aircraft transponder on 1 090 MHz. The radar is able to determine the range and bearing of the aircraft from replies, which can also contain additional data such as aircraft identity, altitude, and speed. Different SSR Modes (A, C, and S) have different additional capabilities with different signal structures including a data channel. Mode A codes aircraft identity and Mode C codes the aircraft-derived barometric altitude. Mode S includes the same capabilities as Mode A/C, but with the additional ability to selectively call specific aircraft and request more advanced aircraft data. SSRs are an essential component of air traffic control systems.

Table A1-2 contains suggested characteristics for the SSR ground interrogator receiver and the SSR airborne transponder receiver.

Table A1-2

**SSR system receiver performance and antenna assumptions**

| Parameters | SSR airborne transponder | SSR ground interrogator |
| --- | --- | --- |
| Centre frequency, MHz | 1 030 | 1 090 |
| Bandwidth, MHz | 6 | 4.5 (Mode A and C)2.3 (Mode S) |
| Maximum antenna gain, dBi | 2.8 / 5.4 | 27 |
| Antenna polarization | Vertical | Vertical |
| Cable loss, dB | 1 | 1 |
| Selectivity, attenuation (dB) @ freq offset (MHz) | 3 @ 324.6 @ 1040 @ 1560 @ 25 | 3 @ 324.6 @ 1040 @ 1560 @ 25 |
| Noise figure, dB | 5 | 5 |

**A1.2.3 Automatic Dependent Surveillance-Broadcast (ADS-B) 1 090 MHz extended squitter**

ADS-B using 1 090 MHz extended squitter (1090ES) provides air-to-air, air-to-ground, air-to-space datalink capabilities. ADS-B messages deliver aircraft identity, aircraft derived position and other aircraft data and are used in air traffic control applications as well as cockpit traffic situational awareness and airspace routing efficiency applications.

Table A1-3 contains suggested characteristics for the ADS-B 1090ES airborne receiver.

Table A1-3

**ADS-B 1090ES system receiver performance and antenna assumptions**

| **Parameters** | **ADS-B (airborne)** | **ADS-B (ground)** | **ADS-B (space)** |
| --- | --- | --- | --- |
| Centre frequency, MHz | 1 090 | 1 090 | 1 090 |
| Bandwidth, MHz | 11 | 11 | 11 |
| Maximum antenna gain, dBi | 2-5 | 6-12 | 8 |
| Antenna polarization | Vertical | Vertical | Vertical |
| Cable loss, dB | 1 | 1 | 1 |
| Selectivity, attenuation (dB) @ freq offset (MHz) | 0 @ 03 @ 5.520 @ 1040 @ 1560 @ 25 | 0 @ 03 @ 5.520 @ 1040 @ 1560 @ 25 | 0 @ 03 @ 5.520 @ 1040 @ 1560 @ 25 |
| Noise figure, dB | 5 | 5 | 5 |

**A1.2.4 Universal Access Transceiver (UAT)**

UAT is an ICAO-standardized system operating on 978 MHz. UAT supports multiple broadcast services, including flight information services (FIS-B) and traffic information services (TIS-B), and automatic dependent surveillance-broadcast (ADS-B). Messages over the UAT datalink are used for cockpit-based weather and traffic monitoring as well as air traffic control applications.

Table A1-4 contains suggested characteristics for the UAT receiver.

Table A1-4

**UAT receiver performance and antenna assumptions**

|  |  |
| --- | --- |
| Parameters | UAT  |
| Centre frequency, MHz | 978 |
| Maximum antenna gain, dBi | 0-4 (airborne)8 (ground) |
| Cable loss, dB | 1-3 |
| Bandwidth, MHz | 1.3 |
| Noise figure, dB | 6 |
| Selectivity, attenuation (dB) @ freq offset (MHz) | 0 @ 03 @ 0.62515 @ 150 @ 260 @ 10 |

**A1.2.5 Multilateration (MLAT) systems**

MLAT may use 1 030 MHz, 1 090 MHz, and 978 MHz. MLAT is intended to be a passive network of ground receivers (of order of 40 to 50 for a large airport) to enable an independent determination of aircraft (and suitably equipped ground vehicles) position on or near an airport using difference in time of arrival techniques. Active interrogations are used when passive receiving is inadequate to meet system performance requirements. When using active interrogations, MLAT systems have several ground-based 1 030 MHz emitters to elicit replies from aircraft transponders and 1 090 MHz emitters to provide constant confirmation of correct system operation. Wide-area multilateration (WAM) is similar to MLAT, but over a wider geographic area. MLAT is used in air traffic control applications, including airport surface movements.

**A1.2.6 Airborne Collision Avoidance System (ACAS)**

ACAS is an aircraft-based avionics system that interrogates aircraft transponders on 1 030 MHz and receives replies from the aircraft transponder on 1 090 MHz. ACAS operates independently of ground-based surveillance equipment and air traffic control to warn pilots of the presence of other aircraft that may present a threat of collision. If the risk of collision is imminent, a manoeuvre is directed to the pilot to reduce the risk of collision.

**MLAT and ACAS technical parameters**

Multilateration systems (MLAT) and airborne collision avoidance systems (ACAS) also operate in the 960-1 215 MHz frequency band. For the purposes of the studies conducted under agenda item 1.13 (WRC-23),WP 5B suggests the studies of the impact to the SSR transponder (Table 2), the ADS-B 1090ES airborne receiver (Table 3) and the UAT airborne receiver (Table 4) would be sufficient to represent the impact to MLAT and ACAS systems.

**A1.2.7 L-band Digital Aeronautical Communication System (LDACS)**

LDACS operating in 960-1 164 MHz is envisaged to use a cellular point-to-multipoint concept, which means that the airspace is segmented into cells. In each cell, all aircraft are connected to a centralized ground station which controls the entire air/ground communication within the cell. It is designed as a frequency-division duplex system that interleaves with DME. LDACS will open a new terrestrial communication link for air traffic control applications.

Table A1-5 contains suggested characteristics for the LDACS receiver.

Table A1-5

**LDACS receiver performance and antenna assumptions**

|  |  |  |
| --- | --- | --- |
| **Parameters** | **LDACS Rx airborne**  | **LDACS Rx ground** |
| Frequency range, MHz | 1 110-1 146 | 964-1 000 |
| Maximum antenna gain, dBi | 5.4 | 12 (typical) |
| Cable loss, dB | 3 | 2 (typical) |
| Duplexer loss, dB | 1 | − |
| Bandwidth, MHz | 0.5 | 0.5 |
| Noise figure, dB | 6 | 6 |
| Selectivity, attenuation (dB) @ freq offset (MHz) | 0 @ 0.256 @ 0.340 @ 0.470 @ 0.580 @ 0.7590 @ 1.5 | 0 @ 0.256 @ 0.340 @ 0.470 @ 0.580 @ 0.7590 @ 1.5 |