RECOMMENDATION ITU-R M.1827

Technical and operational requirements for stations of the aeronautical mobile (R) service (AM(R)S) limited to surface application at airports and for stations of the aeronautical mobile service (AMS) limited to aeronautical security (AS) applications in the band 5 091-5 150 MHz

(2007)

Scope

This Recommendation provides technical and operational requirements for stations of the aeronautical mobile (R) service (AM(R)S) limited to surface applications at airports and the aeronautical mobile service (AMS) limited to aeronautical security (AS) applications[1] in the band 5 091-5 150 MHz that should be used by administrations as a technical guideline for establishing conformance requirements for stations for worldwide use.

The ITU Radiocommunication Assembly,

considering

a) that the aeronautical stations will operate on a national, regional and international basis around the world;

b) that circulation of aeronautical stations is usually a subject of a number of national and international rules and regulations including satisfactory conformance to a mutually agreed technical standard and operational requirements of ICAO;

c) that there is a need for identifying the technical and operational requirements for the conformance testing of the aeronautical stations;

d) that the identification of technical and operational requirements for aeronautical stations would provide a common technical basis for facilitating conformance testing of aeronautical stations by various national, regional and international authorities and the development of mutual recognition arrangements for conformance of aeronautical stations;

e) that the technical and operational requirements need to achieve an acceptable balance between radiocommunication equipment complexity and the need for effective use of the radio-frequency spectrum,

considering also

a) that there is a requirement to fully protect all primary services in the band 5 091-5 150 MHz;

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[1] *Terminology*: AS operates in the AMS, and is a new system limited to secure and confidential radiocommunications between aircraft and ground, intended for systems used in response to interruption of aircraft operations that have not been permitted by the appropriate authorities.

b) that results of the studies conducted in accordance with Resolution 414 (Rev.WRC-03) showed the feasibility of using the band 5 091-5 150 MHz by the AM(R)S limited to surface application at airports and by AMS limited to AS applications on a primary basis under certain conditions;

c) that the identification by ITU-R of technical and operational requirements for aeronautical stations operating in the band 5 091-5 150 MHz should prevent unacceptable interference to other services;

d) that technical and operational characteristics should be continuously and accurately measurable and controllable,

recognizing

a) that the band 5 000-5 250 MHz is allocated to the aeronautical radionavigation service on a primary basis;

b) that the band 5 030-5 150 MHz is to be used for the operation of the international standard microwave landing system (MLS) for precision approach and landing; the requirements for this system shall take precedence over other uses of this band in accordance with No. 5.444 of the Radio Regulations (RR),

recommends

1 that the technical and operational requirements for stations of AM(R)S limited to surface application at airports in the band 5 091-5 150 MHz or for stations of AMS limited to AS applications in the band 5 091-5 150 MHz given in Annexes 1 and 2 should be used by administrations as a guideline for ensuring compatibility with FSS[2].

Annex 1

Essential requirements related to compatibility with FSS networks in the band 5 091-5 150 MHz

For the analyses that follow, Table 1 summarizes the assumed FSS receiver characteristics.

TABLE 1

Parameter values used in satellite interference calculations

Parameter	HIBLEO-4 FL
Satellite receiver noise temperature T (K)	550
Antenna effective area at 5 120 MHz (dBm^2)	–35.6
Polarization discrimination L_p (dB)	1
Feed loss L_{feed} (dB)	2.9
Satellite receiver bandwidth B (MHz)	1.23
Satellite receive antenna gain G_r (dBi)	4

[2] Due to the fact that other limits may also be acceptable and that all essential requirements are not covered by this Recommendation, further study is required.

NOTE 1 – The compliance with the pfds defined below would be obtained under free-space propagation conditions.

NOTE 2 – An e.i.r.p. mask can be derived from the pfd value by applying the method given in Annex 2 of this Recommendation. Simplification of the resulting e.i.r.p. mask could also be considered.

I In the band 5 091-5 150 MHz, in order not to exceed a $\Delta T_s/T_s$ of 2% allowable for AM(R)S plus AS, stations in the AM(R)S and stations in the AS cannot operate co-frequency at the same time (within the field of view of a single non-GSO satellite). The practical means for ensuring this needs to be developed taking into account that different administrations within a single FSS footprint may be operating AM(R)S and/or AS.

II Additional requirements on the AM(R)S

The requirements that follow represent technical guidelines to be used by administrations for establishing conformance requirements for stations for worldwide use. Other limits may also be acceptable, however further study is required.

The pfd defined in this section is based on ensuring that the increase in noise temperature of the FSS satellite (i.e. $\Delta T_s/T_s$) due to operation of the AM(R)S does not exceed 2% (i.e. –17 dB). The methodology assumes 250[3] co-channel AM(R)S transmitters operating concurrently within the field of view of the FSS satellite.

Pfd limit computation based on the FSS protection criteria ($\Delta T_s/T_s$ = 2%) and 250 AM(R)S

Assuming the Table 1 characteristics for the FSS, the maximum aggregate interference level tolerable at the receiver input is $I_{Agg\text{-}Rec}$:

$$I_{Agg-Rec} = KTB - 17 \text{ dB} = -157.3 \text{ dB(W / 1.23 MHz)}$$

where:

- K: Boltzmann's constant (1.38×10^{-23})
- T: represents the receiver noise temperature
- B: receiver bandwidth.

Therefore at the satellite receiver antenna input the maximum pfd level produced by one AMRS transmitter is:

$$pfd_{Max} = I_{Agg-Rec} - Gr + L_{Feed} + L_P - 10 \log_{10}(250) + 10 \log\left(\frac{4\pi}{\lambda^2}\right)$$

$$= -157.3 - 4 + 2.9 + 1 - 23.97 + 35.6$$

$$= -145.77 \text{ dBW /(m}^2 \times 1.23 \text{ MHz)}$$

where:

- Gr: FSS receiver antenna gain
- 250: maximum number of AM(R)S stations emitting simultaneously in the FSS receiver bandwidth.

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[3] Based on an assumption of 500 airports and a 50% duty cycle.

III Additional requirements on the AS

The requirements that follow represent technical guideline to be used by administrations for establishing conformance requirements for stations for worldwide use. Other limits may also be acceptable, however further study is required.

The pfd defined in this section is based on ensuring that the increase in noise temperature of the FSS satellite (i.e. $\Delta T_s/T_s$) due to operation of the AS does not exceed 2% (i.e. –17 dB). The methodology assumes 70 co-channel AS transmitters operating concurrently within the field of view of the FSS satellite.

Pfd limit computation based on the FSS protection criteria ($\Delta T_s/T_s$ = 2%) and 70 AS

Assuming the Table 1 characteristics for the FSS, the maximum aggregate interference level tolerable at the receiver input is $I_{Agg\text{-}Rec}$:

$$I_{Agg-Rec} = KTB - 17 \text{ dB} = -157.3 \text{ dB(W / 1.23 MHz)}$$

where:

K: Boltzmann’s constant (1.38×10^{-23})

T: represents the receiver noise temperature

B: receiver bandwidth.

Therefore, at the satellite receiver antenna input the maximum pfd level produced by one AS transmitter is:

$$\begin{aligned} pfd_{Max} &= I_{Agg-Rec} - Gr + L_{Feed} + L_P - 10 \log_{10}(70) + 10 \log\left(\frac{4\pi}{\lambda^2}\right) \\ &= -157.3 - 4 + 2.9 + 1 - 18.45 + 35.6 \\ &= -140.25 \text{ dBW /(m}^2 \times 1.23 \text{ MHz)} \end{aligned}$$

where:

Gr: FSS receiver antenna gain

70: maximum number of AS station emitting simultaneously in the FSS receiver bandwidth.

Annex 2

Derivation of a higher hemisphere e.i.r.p. mask from a pfd limit

In testing AM(R)S or AS equipment to determine if it meets a given pfd limit, such as those in Annex 1, it may be useful to determine an equivalent e.i.r.p. mask that can be used for testing purposes.

The pfd limit can be used to mathematically determine a higher hemisphere e.i.r.p. mask, e.i.r.p. (θ, *H*) where θ is the angle above the local horizontal plane and *H* is the altitude of the aircraft. This conversion proceeds in two steps. First, θ is converted to an equivalent angle below the horizontal at the satellite, γ. Then the length of the propagation path for angle above the horizontal θ is determined and used to calculate the spreading loss for the path and the resulting e.i.r.p.

Step 1: Calculation of an angle below the horizontal at the satellite in degrees, γ, from θ and *H*:

$$\gamma = \arccos\left((R_e + H) \times \cos\left(\frac{\theta}{R_e + H_{Sat}} \right) \right)$$

where:

- θ: angle above the horizontal at the AS
- R_e: Earth radius (6 378 km)
- H: altitude of the aircraft (km)
- H_{sat}: altitude of the FSS satellite (km)
- γ: angle below horizontal at the satellite.

Step 2: Calculation of the e.i.r.p. value from the defined pfd limit:

$$d = \left((R_e + H)^2 + (R_e + H_{sat})^2 - 2(R_e + H)(R_e + H_{sat})\cos(\gamma - \theta) \right)^{1/2}$$

$$\text{e.i.r.p.}(\theta, H) = \text{pfd} + 10\log_{10}(4\,\pi\, d^2) + 60$$

where:

- d: distance between the AS and the considered point on the Earth's surface (km)
- pfd: pfd limit (dB(W/(m^2 · MHz)))
- e.i.r.p.: (dB(W/MHz)).

The graph in Fig. 1 shows this function for an aircraft altitudes of 12 km based on the pfd limit provided in Annex 1, Part III Annex 1, and an assumed satellite altitude, H_{sat} of 1 414 km.

FIGURE 1

e.i.r.p. max versus angle above the horizontal