



Recommendation ITU-R M.1903
(01/2012)

**Characteristics and protection criteria
for receiving earth stations in the
radionavigation-satellite service
(space-to-Earth) and receivers
in the aeronautical radionavigation
service operating in the band
1 559-1 610 MHz**

M Series
**Mobile, radiodetermination, amateur
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SA	Space applications and meteorology
SF	Frequency sharing and coordination between fixed-satellite and fixed service systems
SM	Spectrum management
SNG	Satellite news gathering
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Note: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.

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RECOMMENDATION ITU-R M.1903

**Characteristics and protection criteria for receiving earth stations
in the radionavigation-satellite service (space-to-Earth) and
receivers in the aeronautical radionavigation service¹
operating in the band 1 559-1 610 MHz**

(Questions ITU-R 217-2/4 and ITU-R 288/4)

(2012)

Scope

Characteristics and protection criteria for radionavigation-satellite service (RNSS) receiving earth stations and aeronautical radionavigation service (ARNS) receiving stations operating in the band 1 559-1 610 MHz are presented in this Recommendation. This information is intended for performing analyses of radio frequency interference impact on RNSS (space-to-Earth) and ARNS receivers operating in the band 1 559-1 610 MHz from radio sources other than in the RNSS.

The ITU Radiocommunication Assembly,

considering

- a) that systems and networks in the radionavigation-satellite service (RNSS) provide worldwide accurate information for many positioning, navigation and timing applications, including safety aspects for some frequency bands and under certain circumstances and applications;
- b) that any properly equipped earth station may receive navigation information from systems and networks in the RNSS on a worldwide basis;
- c) that there are various operating and planned systems and networks in the RNSS;
- d) that there is an essential need to protect systems and networks operating in the ARNS and RNSS in the band 1 559-1 610 MHz;
- e) that RNSS safety services exist, and that the use of these services will expand in the future;
- f) that the International Civil Aviation Organization (ICAO) has developed standards for the global navigation satellite system (GNSS), whose elements include systems and networks in the RNSS;
- g) that the International Maritime Organization (IMO) requires ships to equip with RNSS for navigation in narrow waterways and for docking;
- h) that there are a large number of aeronautical and non-aeronautical RNSS applications that use or plan to use the 1 559-1 610 MHz band;
- j) that Recommendation ITU-R M.1787 provides technical descriptions of systems and networks in the RNSS and technical characteristics of transmitting space stations operating in the bands 1 164-1 215 MHz, 1 215-1 300 MHz and 1 559-1 610 MHz;

¹ For the purposes of this Recommendation, references to the aeronautical radionavigation service (ARNS) include only terrestrial transmitters that transmit an RNSS-like signal intended for reception by receivers that also receive RNSS signals. As a result, the criteria specified in this Recommendation for RNSS receivers also apply to these ARNS receivers.

k) that Recommendation ITU-R M.1904 provides technical characteristics and protection criteria of receiving space stations operating in the RNSS (space-to-space) in the bands 1 164-1 215 MHz, 1 215-1 300 MHz and 1 559-1 610 MHz;

l) that Recommendation ITU-R M.1901 provides guidance on this and other ITU-R Recommendations related to systems and networks in the RNSS operating in the frequency bands 1 164-1 215 MHz, 1 215-1 300 MHz, 1 559-1 610 MHz, 5 000-5 010 MHz and 5 010-5 030 MHz,

recognizing

a) that the band 1 559-1 610 MHz is allocated on a primary basis to the RNSS (space-to-Earth) (space-to-space) and ARNS in all three Regions;

b) that there are a number of receivers of RNSS signals used in safety service applications that process these signals in different ways, as described in Annex 2;

c) that there are a number of different existing and planned augmentations of systems and networks in the RNSS which support safety services;

d) that Recommendation ITU-R M.1343 defines the essential technical requirements of mobile earth stations (MESs) for global non-GSO MSS systems in the bands 1-3 GHz;

e) that No. 5.362B provides that the band 1 559-1 610 MHz is also allocated to the fixed service on a primary basis until 1 January 2010 in a number of countries; that the fixed service may continue to operate on a secondary basis in these countries from 1 January 2010 to 1 January 2015, after which the allocation is no longer valid; that in a number of other countries the band 1 559-1 610 MHz is allocated to the fixed service on a secondary basis until 1 January 2015, after which time the allocation is no longer valid; and that administrations of all countries listed in No. 5.326B are urged to take all practicable steps to protect the RNSS and the ARNS and not authorize new frequency assignments to fixed-service systems in the band;

f) that No. 5.362C provides that the band 1 559-1 610 MHz is also allocated to the fixed service on a secondary basis in a number of countries until 1 January 2015, after which the allocation is no longer valid; and that administrations of all countries listed in No. 5.326C are urged to take all practicable steps to protect the RNSS and not authorize new frequency assignments to fixed-service systems in the band,

recommends

1 that the characteristics and protection criteria of receiving earth stations given in Annex 2 should be used in performing analyses of the interference impact on ARNS and RNSS (space-to-Earth) receivers operating in the band 1 559-1 610 MHz from radio sources other than in the RNSS;

2 that a safety margin, as discussed in Annex 1, should be applied for the protection of the safety aspects and applications of the RNSS and ARNS, when performing interference analyses;

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

NOTE 1 – This Recommendation is not intended to be used to form the basis for future modifications to maximum unwanted emission levels for the band 1 559-1 610 MHz that are stated in the Annexes to Recommendations ITU-R M.1343-1 and ITU-R M.1480 for MSS MESs, and ITU-R SM.1757 for UWB. The maximum unwanted emission levels for the band 1 559-1 610 MHz stated in Recommendations ITU-R M.1343-1 and ITU-R M.1480 have been developed pursuant to a specific interference scenario, and are not intended to be applied to any service other than MSS MESs operating in the 1-3 GHz range without further study. Levels given in Recommendation ITU-R SM.1757 are specific to ultra-wideband technology.

NOTE 2 – The 6 dB aeronautical radionavigation safety margin, as discussed in § 3 of Annex 1, was developed for a specific aeronautical radionavigation application of the RNSS and ARNS in the

band 1 559-1 610 MHz, and was not intended to be applied to non-aeronautical applications. The level of the safety margin, if any, to be applied to non-aeronautical safety applications of RNSS is to be established on the basis of further study.

Annex 1

Margin for safety applications in the RNSS

1 Introduction

There is a long history within ITU and ICAO of reserving a portion of the interference link budget for a margin in order to ensure that the safety aspects of the radionavigation service are protected. These margin values typically lie in the range of 6 to 10 dB, or more. Furthermore, there is ample precedent for a safety margin for radionavigation safety applications in ITU-R, for example:

“Regardless of the original intentions of radio spectrum planners, there can be no doubt that the pressure on the radio spectrum for additional allocations to the various radio communication services can result in aeronautical protection criteria being effectively regarded as non-aeronautical sharing criteria. As a consequence, a safety service must take considerable precautions to ensure that any radio service sharing the same radio band is constrained sufficiently to leave an adequate margin under all likely circumstances so that the aggregate harmful interference never exceeds the required protection criteria.”²

Also, Recommendation ITU-R M.1318-1 contains, in its Annex, a model for the evaluation of interference to RNSS receivers from radio sources other than in the RNSS. That model includes the use of a factor called “protection margin (dB)”. Its description states that it is used “to ensure protection as provided by RR No. 4.10.”

2 Purpose of safety margin

A safety margin (which may also be called a public safety factor), is critical for safety-of-life applications in order to account for risk of loss of life due to radio-frequency interference that is real but not quantifiable. To support safety-of-life applications, all interference sources must be accounted for.

3 Aeronautical radionavigation applications of safety margin

3.1 Aeronautical radionavigation safety margin background

The utilization of safety margins in navigation systems is well established. ICAO specifies a safety margin for the microwave landing system (MLS) of 6 dB (Annex 10 to ICAO Convention: International Standards and Recommended practices Aeronautical Telecommunications, Vol. 1 – Radio Navigation Aids (Attachment G, Table G-2)). The instrument landing system (ILS) applies a safety margin of 8 dB (see Recommendation ITU-R SM.1009-1, Appendix 3 to Annex 2). In each case the margin is defined with respect to the navigation system carrier power.

That is, to test system performance for these systems, the desired signal power is reduced from the nominal level by the safety margin, and then tested to determine whether the system provides the

² This text appeared in Annex 5 of Recommendation ITU-R M.1477 (Geneva, 2000), among other places.

required performance in the presence of interference. In other words, the manufacturer must design the equipment to handle the highest anticipated interference level while receiving a desired signal level lower (by the safety margin) than would be otherwise received.

With GNSS³ this approach is not possible, because reducing the carrier power by 6 dB or more below the designed power could result in satellites being dropped in the tracking algorithm of the receiver. This is because the received GNSS satellite power is relatively limited, and thus GNSS receivers operate over a small dynamic range. For GNSS receivers, the principal received signal quality measure is the $C/N_{0,EFF}$ ratio, the ratio of the recovered carrier power, C , to the effective noise + interference power spectral density, $N_{0,EFF} = N_0 + I_0$. GNSS receivers must be capable of operating near the minimum $C/N_{0,EFF}$ value, a region where important performance parameters, such as detected word error rate or carrier phase error, rise rapidly for small reductions in $C/N_{0,EFF}$ due, for example, to interference.

3.2 Safety margin for the GNSS in the band 1 559-1 610 MHz

As with the MLS and ILS, the approach for the GNSS is to define a level of non-aeronautical radio-frequency interference⁴ (RFI) that the receiver must be able to accept and still meet performance specifications. For the GNSS, the receiver RFI test limit (i.e. the design threshold) exceeds the maximum allowable environmental aggregate interference level by a safety margin. Specifically, if the aggregate continuous interference test limit for GNSS is $J_{agg,max}$ (dBW) and a safety margin, M (dB), is used, then the maximum safe environmental aggregate continuous RFI, $J_{safe,max}$ (dBW) is:

$$J_{safe,max} = J_{agg,max} - M$$

For the GNSS in the 1 559-1 610 MHz band, the necessary safety margin, M (dB), is 6 dB.

A safety margin of 5.6 dB was used in the development of the -70 dB(W/MHz) emission limit adopted in Recommendation ITU-R M.1343-1. However, for general application this margin is adjusted slightly to 6 dB, which brings it into the range of safety service margins which have been adopted by ITU-R for other safety applications, as indicated in § 3.1 above.

For example, a Category I precision approach SBAS Type 1 air navigation receiver (see Table 2 of Annex 2) operating in the $1\,575.42 \pm 12$ MHz band is designed and tested to withstand a wideband aggregate interference threshold level of -140.5 dB(W/MHz) in the signal tracking mode. Applying the 6 dB safety margin, as indicated in the equation above, to the aggregate threshold results in the safe level of allowable received interference of -146.5 dB(W/MHz).

An aeronautical safety margin of at least 6 dB is required to protect the GNSS safety applications. Additional margins may be required, depending on:

- the effects of the statistics on all parameters used in interference analyses unless the worst-case conditions are assumed; and
- RFI sources that are not specifically included in the interference analysis but that may have a potential to contribute to the interference of GNSS.

³ GNSS refers to Global Navigation Satellite System, a set of RNSS systems providing aeronautical radionavigation satellite signals as recognized by ICAO.

⁴ Non-aeronautical interference refers to interference from sources other than aeronautical equipment installed on the GNSS receiver-equipped aircraft.