



**Recommendation ITU-R M.1902**  
(01/2012)

**Characteristics and protection criteria  
for receiving earth stations in the  
radionavigation-satellite service  
(space-to-Earth) operating  
in the band 1 215-1 300 MHz**

**M Series**  
**Mobile, radiodetermination, amateur  
and related satellite services**

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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.1902

**Characteristics and protection criteria for receiving earth stations  
in the radionavigation-satellite service (space-to-Earth)  
operating in the band 1 215-1 300 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 operating in the band 1 215-1 300 MHz are presented in this Recommendation. This information is intended for performing analyses of radio-frequency interference impact on RNSS (space-to-Earth) receivers operating in the band 1 215-1 300 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 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;
- d) 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;
- e) that Recommendation ITU-R M.1463 contains system characteristics for radiodetermination systems in the 1 215-1 400 MHz band;
- f) 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 1 215-1 300 MHz is allocated on a primary basis to the Earth exploration-satellite service (EESS) (active), radiolocation service, RNSS (space-to-Earth and space-to-space) and space research service (active) in all three Regions;
- b) that in a number of countries the band 1 215-1 300 MHz also contains primary allocations to the fixed and mobile services, and/or to the radionavigation service (limited in some cases to aeronautical radionavigation use in a portion of the band);
- c) that No. **5.329** of the Radio Regulations (RR) states: "Use of the radionavigation-satellite service in the band 1 215-1 300 MHz shall be subject to the condition that no harmful interference is caused to, and no protection is claimed from, the radionavigation service authorized under RR No. **5.331**. Furthermore, the use of the radionavigation-satellite service in the band

1 215-1 300 MHz shall be subject to the condition that no harmful interference is caused to the radiolocation service. RR No. 5.43 shall not apply in respect of the radiolocation service. Resolution 608 (WRC-03) shall apply”;

d) that RR No. **5.332** states that EESS (active) in the band 1 215-1 260 MHz shall not cause harmful interference to RNSS,

*noting*

that Recommendation ITU-R RS.1749 contains characteristics for various space-borne synthetic aperture radars in the band 1 215-1 300 MHz and Recommendation ITU-R RS.1347 recommends that sharing be considered feasible in the band 1 215-1 260 MHz between space-borne synthetic aperture radars and RNSS based on demonstrations including ground compatibility testing,

*recommends*

**1** that the characteristics and protection criteria of receiving earth stations given in Annex 1 should be used in performing analyses of the interference impact on RNSS (space-to-Earth) receivers operating in the band 1 215-1 300 MHz from radio sources other than in the RNSS.

## Annex 1

### **Technical characteristics and protection criteria for receiving earth stations in the RNSS (space-to-Earth) operating in the band 1 215-1 300 MHz**

#### **1 Introduction**

Several classes of receivers that vary in terms of function and performance are likely to use the RNSS satellite signals in the 1 215-1 300 MHz frequency band. The sections below include a general description of each type of RNSS receiver and a description of the receiver characteristics and protection criteria. Several of the receivers described are multiple-frequency band receiver types that use or plan to use RNSS signals simultaneously for this and one or more other RNSS bands.

#### **2 RNSS receiver application descriptions**

This section describes several types of current and prospective RNSS receivers.

##### **2.1 Satellite-based augmentation system<sup>1</sup> ground reference receiver**

This ground-based receiver type is used in satellite-based augmentation system (SBAS) ground network operations to determine ionospheric delays and RNSS signal integrity. The receiver uses a semi-codeless technique that exploits a unique feature enabled by the particular RNSS signal architecture whereby the L1 and L2 P(Y) signals are tracked, aided by the knowledge of dynamic

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<sup>1</sup> SBAS is a means for providing RNSS regional measurement error correction and integrity data via GSO satellite signals.

carrier phase obtained from L1 C/A<sup>2</sup> code and carrier tracking, and the knowledge of the average encryption clocking rate. This cross-correlation technique provides the capability to measure the signal delay at L2, thus making it possible to determine the signal delay variations due to the ionosphere. The cross-correlation scheme is made possible in part by the fact that the L1 and L2 P(Y) signals have identical codes. This receiver must also acquire and track SBAS satellite signals at the same frequency as the L1 C/A carrier. Semi-codeless receivers are more sensitive to interference because they operate without benefit of knowing the Y code<sup>3</sup>. Acquisition is performed using the L1 C/A code signal. Acquisition at L2 is not applicable for this type of receiver. The characteristics and protection criteria for this receiver are provided in Table 1-1, column 1. Since the receiver uses L1 C/A and P(Y) signals simultaneous with L2 P(Y), it is also susceptible to interference in the band 1 559-1 610 MHz. Protection criteria and other characteristics for the SBAS ground reference receiver in that frequency band are specified in Recommendation ITU-R M.1903.

SBAS ground reference receivers serve critical roles, such as integrity monitoring of RNSS systems, at SBAS ground stations in known fixed locations. Hence appropriate protection to ensure continuous uninterrupted access to RNSS signals exists for these receivers, such as, but not limited to, physical buffer zones.

## 2.2 RNSS semi-codeless receivers

### 2.2.1 High-precision semi-codeless receivers

High-precision semi-codeless receivers are used primarily for surveying and other precise positioning applications (e.g. precision agriculture, scientific) where measurements of ionospheric delay are required. Similar to the SBAS ground reference receiver above, these semi-codeless receivers use a technique whereby the L1 and L2 P(Y) signals are tracked, aided by the knowledge of dynamic carrier phase obtained from L1 C/A code tracking. There are two basic methods for this: 1) L1 and L2 P(Y) signals are cross-correlated, or 2) the signals are actually independently tracked. High-precision receivers acquire and track RNSS signals in two or three frequency bands for proper operation and require protection in all bands used.

There are also variations to these methods or combinations of the two methods. In any case, the purpose is to provide an estimate of the ionospheric delay or an independent set of carrier phase measurements that support rapid removal of wavelength ambiguities, even when the receiver is in motion. This process provides improved position accuracy. The cross-correlation scheme is made possible by the fact that L1 and L2 have identical, nearly synchronized P(Y) codes. The L2 P(Y) signal codes are delayed through the ionosphere relative to the L1 P(Y) signal codes, and also accompanied by carrier phase advances. The L1 P(Y) signal has the identical code and carrier Doppler as the L1 C/A signal, which allows the ability to aid the semi-codeless tracking using very narrow bandwidth tracking loops. This receiver will have characteristics similar to the SBAS ground reference receiver described above, but may differ in its susceptibility to interference. The characteristics of this type of receiver are provided in Table 1-1, column 2. Since this receiver also uses 1 559-1 610 MHz band signals, it is susceptible to interference in that band. Protection criteria and other characteristics in the 1 559-1 610 MHz band specified for the CDMA-type high-precision receiver are found in Recommendation ITU-R M.1903.

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2 The L1 C/A and L1 P(Y) signals are in the 1 559-1 610 MHz RNSS frequency band while L2 P(Y) signals are in the 1 215-1 300 MHz RNSS band. Further details for these signals are found in Annex 2 (GPS) of Recommendation ITU-R M.1787.

3 Y code is a modified and encrypted P code, having the same chipping rate and modulation characteristics as that of the P code.

### 2.2.2 L2C-transitional high-precision semi-codeless receivers

This receiver has all the characteristics of the high-precision semi-codeless receiver in section 2.2.1 and also acquires and tracks the new L2C signal<sup>4</sup> on the L2 carrier received from available later-generation satellites. This receiver will use the semi-codeless technique described above to acquire and track L2 P(Y) signals on other earlier-generation satellites, and may use that technique on L2 P(Y) signals received from the later-generation satellites as well, at least to provide calibration information for the hybrid L2C/L2 P(Y) operations. This hybrid operation requires that the phase difference between the L2C and L2 P(Y) signals is known. The L2C signal provides more robustness than available with the L2 P(Y) semi-codeless operation that is beneficial in more stressed environments. However, since receivers with this capability are used in system applications that also use the legacy L2 P(Y) semi-codeless receivers, in general, this extra robustness is not always available. Thus, the threshold interference power levels specified in Table 1-1, column 2 still apply.

### 2.3 High-precision receivers using L2C

This receiver type is a ground-based receiver that will acquire and track the L2C signal, but not necessarily the L2 P(Y) signal. The function of this receiver is the same as the function of the high-precision semi-codeless receiver described above, but with more robustness gained from acquiring and tracking the L2C signal.

This receiver type acquires and tracks the new L2C code received from certain later-generation satellites. This receiver may also use the semi-codeless technique described above to acquire and track L2 P(Y) signals from these and other satellites as well, at least to provide calibration information for the hybrid L2C/L2 P(Y) operations. This hybrid operation requires that the phase difference between the L2C and L2 P(Y) signals is known. The characteristics of this type of receiver that acquires and tracks the L2C signal are provided in Table 1-1, column 3. The L2C signal provides more robustness than available with the L2 P(Y) semi-codeless operation that is beneficial in more stressed environments. However, since receivers with this capability are used in system applications that also use the legacy L2 P(Y) semi-codeless receivers, in general, this extra robustness is not always available. Thus, the threshold interference power levels specified in column 2 of Table 1-1 also apply.

### 2.4 Air-navigation receiver

Air-navigation refers to an airborne receiver designed for use from en-route through precision approach. This receiver type uses FDMA RNSS signals<sup>5</sup> and operates on several carrier frequencies simultaneously. Characteristics of this receiver type are specified in Table 1-1, column 4.

Characteristics for the FDMA air-navigation receivers may also apply to receivers developed for land and maritime applications that are not described in this Annex.

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4 Further details of the L2C signal are found in Annex 2 (GPS) of Recommendation ITU-R M.1787.

5 The phrase "FDMA RNSS signals" refers to a technique in which all the RNSS satellites use the same modulation code, but each satellite transmits on a different carrier frequency. Further signal details are contained in Annex 1 (GLONASS) of Recommendation ITU-R M.1787.

## 2.5 Indoor positioning

The indoor positioning category represents RNSS receivers intended for indoor use and that typically have a low  $C/N_0$  capability (i.e. very sensitive receivers). Because carrier tracking cannot be used with the low-power signals present in indoor environments, only code tracking is used in this type of receiver. Two receiver types are listed in Table 1-1, column 5; each of which uses a different RNSS satellite signal type (either CDMA, for the L2C signal, or FDMA), frequency range and filter bandwidths. The protection criteria and remaining characteristics are the same.

## 2.6 “Others”

The “Others” category represents other RNSS applications using general-purpose and handheld receivers. Characteristics<sup>6</sup> and protection criteria for this receiver type are specified in Table 1-1, column 6.

## 2.7 General-purpose applications

The general-purpose category represents several types of RNSS receivers. These receivers are designed for vehicular navigation, pedestrian navigation, general positioning, etc. Two receiver types are listed in Table 1-1, column 7; each of which uses a different RNSS satellite signal type (either CDMA, for the L2C signal, or FDMA), frequency range and filter bandwidths. The protection criteria and remaining characteristics are the same.

## 3 Pulsed radio-frequency interference radio frequency effects

In addition to continuous interference from a variety of sources, including RNSS space stations, RNSS receivers operating in the 1 215-1 300 MHz band are subjected to in-band and adjacent band pulsed radio frequency interference (RFI) from radiolocation radars and ARNS transmitters. The presence of pulsed RFI reduces the amount of continuous RFI that the RNSS receiver can tolerate. The amount of pulsed RFI depends on the number of pulsed sources within the radio horizon of the RNSS receive antenna.

A different RFI analysis method is needed to account for pulsed RFI in the 1 215-1 300 MHz band than, for example, in the 1 559-1 610 MHz band, where pulsed RFI is insignificant. Studies by two aviation standards organizations<sup>7</sup> have identified an analysis method that addresses the combined effect of pulsed and continuous RFI<sup>8</sup>. Two variations in the basic method were derived that depend on the type of RNSS receiver pulse mitigation: one for pulse-blanking receivers (with higher duty cycle pulsed RFI); and one for more general-purpose, saturating receivers (suitable for lower duty cycle pulsed RFI). The SBAS ground reference receiver (see § 2.1) incorporates pulse blanking for improved performance in the presence of pulsed RFI.

## 4 RNSS receiver technical characteristics and protection criteria

Table 1-1 lists technical characteristics and protection criteria (maximum aggregate interference thresholds) for several representative RNSS receivers and applications in the 1 215-1 300 MHz band. More RNSS signal information can be found in Recommendation ITU-R M.1787.

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6 Further RNSS signal details are found in Annex 4 (QZSS) of Recommendation ITU-R M.1787.

7 RTCA, headquartered in the United States of America, and EUROCAE in Europe.

8 RTCA SC-159, “Assessment of the radio frequency interference relevant to the GNSS L5/E5A frequency band”, RTCA Document No. RTCA/DO-292, Washington, DC, 29 July 2004.

Table 1-1 proposes different levels of protection depending on the RNSS applications. The following RNSS receivers and applications have been included in the table:

- SBAS ground reference receiver (see § 2.1 and Table 1-1, column 1).
- High-precision semi-codeless receiver (see § 2.2.1 and Table 1-1, column 2) (Note that column 2 also applies to the L2C transitional high-precision, semi-codeless receiver; see § 2.2.2).
- High-precision receiver using L2C (see § 2.3 and Table 1-1, column 3).
- Air-navigation receiver (see § 2.4 and Table 1-1, column 4).
- Indoor positioning (2 types) (see § 2.5 and Table 1-1, column 5).
- “Others” (see § 2.6 and Table 1-1, column 6).
- General-purpose (2 types) (see § 2.7 and Table 1-1, column 7).



TABLE 1-1

Technical characteristics and protection criteria for RNSS receivers (space-to-Earth) operating in the band 1 215-1 300 MHz

	1	2	3	4	5		6	7	
Parameter	SBAS ground reference receiver*	High-precision semi-codeless receiver*	High-precision receiver using L2C*	Air-navigation receiver (Note 10)	Indoor positioning		Others	General purpose	
Signal frequency range (MHz)	1 227.6 ± 15.345	1 227.6 ± 15.345	1 227.6 ± 15.345	1 246 + 0.4375*K ± 5.11, where K = -7, ..., +6 (Note 8)	1 227.6 ± 12	1 246 + 0.4375*K ± 5.11 where K = -7, ..., +6	1 278.75 ± 21	1 227.6 ± 12	1 246 + 0.4375*K ± 5.11 where K = -7, ..., +6
Maximum receiver antenna gain in upper hemisphere (dBi)	-2.0 circular (Note 3)	3.0 circular	3.0 circular	7 (Note 11)	6		6	6	
Maximum receiver antenna gain in lower hemisphere (dBi)	-5.0 circular (see Note 3)	-7 linear (< 10° elev.)	-7 linear (< 10° elev.)	-10	6 (Note 12)		6 (Note 12)	6 (Note 12)	
RF filter 3 dB bandwidth (MHz)	24.0	24.0	24.0	30	32	30	64	32	30
Pre-correlation filter 3 dB bandwidth (MHz)	20.46	20.46	20.46	20	2	20	50	2	20
Receiver system noise temperature (K)	513	513	513	400	645		645	645	
Tracking mode threshold power level of aggregate narrow-band interference at the passive antenna output (dBW)	-137.5 (P(Y)) (Note 1)	-137.4 (P(Y)) (Note 1)	-151.4 (Note 1)	-149 (Note 9)	-193 (Note 1)		-119 (Note 2)	-158 (Note 1)	
Acquisition mode threshold power level of aggregate narrow-band interference at the passive antenna output (dBW)	See Note 4	See Note 5	-157.4 (Note 1)	-155 (Note 9)	-199 (Note 1)		-125 (Note 2)	-164 (Note 1)	
Tracking mode threshold power density level of aggregate wideband interference at the passive antenna output (dB(W/MHz))	-147.5 (P(Y)) (Note 1)	-147.4 (P(Y)) (Note 1)	-147.4 (Note 1)	-140 (Note 9)	-150 (Note 1)		-121 (Note 2)	-139 (Note 1)	
Acquisition mode threshold power density level of aggregate wideband interference at the passive antenna output (dB(W/MHz))	See Note 4	See Note 5	-147.4 (Note 1)	-146 (Note 9)	-156 (Note 1)		-127 (Note 2)	-145 (Note 1)	

TABLE 1-1 (*end*)

	1	2	3	4	5	6	7
Parameter	SBAS ground reference receiver*	High-precision semi-codeless receiver*	High-precision receiver using L2C*	Air-navigation receiver (Note 10)	Indoor positioning	Others	General purpose
Receiver input compression level (dBW)	-135.0 (Note 6)	#	#	-80	-70	-70	-70
Receiver survival level (dBW)	-10.0 (Note 7)	#	#	-1	-20	-20	-20
Overload recovery time (s)	$1.0 \times 10^{-6}$	#	#	$(1 \text{ to } 30) \times 10^{-6}$	$30 \times 10^{-6}$	$30 \times 10^{-6}$	$30 \times 10^{-6}$

\* These table columns cover characteristics and thresholds for RNSS receivers that operate in the 1 215-1 300 MHz band. (Receivers of this type operate with the signals described in Annex 2 to Recommendation ITU-R M.1787.) For characteristics and protection criteria for the receiver operation in the bands 1 559-1 610 MHz and/or 1 164-1 215 MHz, refer also to the associated table columns in Recommendations ITU-R M.1903 and/or ITU-R M.1905, respectively.

# Pulse response parameters for these receiver types are subject to further study in conjunction with ITU-R work on a general pulsed RFI evaluation method.

NOTE 1 – For P(Y) signal processing, including that using semi-codeless techniques, narrow-band interference is considered to have less than a 100 kHz bandwidth and wideband interference has greater than a 1 MHz bandwidth. For L2C signal processing, narrow-band interference is considered to have less than a 1 kHz bandwidth and wideband interference has greater than a 1 MHz bandwidth. For FDMA signal processing, narrow-band continuous interference is considered to have less than a 1 kHz bandwidth, and wideband continuous interference is considered to have greater than a 500 kHz bandwidth. Thresholds for interference bandwidths between 100 kHz (for P(Y)) or 1 kHz (for L2C and FDMA) to 1 MHz (or for FDMA to 500 kHz) are undefined and may require further study.

NOTE 2 – Narrow-band continuous interference is considered to have a bandwidth less than 700 Hz. Wideband continuous interference is considered to have a bandwidth greater than 1 MHz.

NOTE 3 – The listed maximum upper hemisphere gain value applies for 30° elevation (i.e. maximum expected RFI arrival angle). The listed maximum lower hemisphere gain value applies for 0° elevation (i.e. at the horizon).

NOTE 4 – Signal acquisition is performed using the L1 C/A signal. See the appropriate acquisition threshold row in Recommendation ITU-R M.1903 Annex 2, Table 2-2, “SBAS Ground Reference Receiver” column.

NOTE 5 – Signal acquisition is performed using the L1 C/A signal. See the appropriate acquisition threshold row in Recommendation ITU-R M.1903 Annex 2, Table 2-2, “High-precision” column.

NOTE 6 – The input compression level is for power in a 1 MHz bandwidth.

NOTE 7 – The survival level is the peak power level for a pulsed signal with a 10% maximum duty factor.

NOTE 8 – This receiver type operates on several RNSS signal carrier frequencies simultaneously. The carrier frequencies are defined by  $f_c$  (MHz) = 1 246.0 + 0.4375  $K$ , where  $K$  = -7 to +6.

NOTE 9 – This threshold should account for the aggregate power of all interference. The threshold value does not include any safety margin.

NOTE 10 – Given values represent typical characteristics of receivers. Under certain conditions more rigid values for some parameters could be required (e.g. recovery time after overload, threshold values of aggregate interference, etc.).

NOTE 11 – Minimum receiver antenna gain at 5 degrees elevation angle is -4.5 dBi.

NOTE 12 – Because the antenna in some RNSS receiver applications could potentially be pointed in almost any direction, the maximum antenna gain in the lower hemisphere could (under worst-case conditions) be equal to that for the upper hemisphere.