International Telecommunication Union

ITU-R

Radiocommunication Sector of ITU

Recommendation ITU-R M.1902-2

(01/2022)

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

International Telecommunication Union

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Electronic Publication
Geneva, 2022

RECOMMENDATION ITU-R M.1902-2

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)

(2012-2019-2022)

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. It is worth mentioning that it is expected that this Recommendation should be used for civilian purposes.

Keywords

RNSS, protection criteria, radiofrequency interference impact

Abbreviations/Glossary

AWGN	Additive white Gaussian noise
PDC	Pulse duty cycle
PNT	Position, navigation and timing
PRF	Pulse repetition frequency
RHCP	Right-hand circular polarization
SQPN	Staggered quadrature pseudo-random noise
SQPSK	Staggered quadrature phase-shift keying
SSC	Spectral separation coefficient

Related ITU Recommendations, Reports

Recommendation ITU-R M.1318-1	Evaluation model for continuous interference from radio sources other than in the radionavigation-satellite service to the radionavigation-satellite service systems and networks operating in the 1 164-1 215 MHz, 1 215-1 300 MHz, 1 559-1 610 MHz and 5 010-5 030 MHz bands
Recommendation ITU-R M.1787-4	Description of systems and networks in the radionavigation-satellite service (space-to-Earth and space-to-space) 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
Recommendation ITU-R M.1901-3	Guidance on ITU-R Recommendations related to systems and networks in the radionavigation-satellite service 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

Recommendation ITU-R M.1903-1	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
Recommendation ITU-R M.1904-1	Characteristics, performance requirements and protection criteria for receiving stations of the radionavigation-satellite service (space-to-space) operating in the frequency bands 1 164-1 215 MHz, 1 215-1 300 MHz and 1 559-1 610 MHz
Recommendation ITU-R M.1905-1	Characteristics and protection criteria for receiving earth stations in the radionavigation-satellite service (space-to-Earth) operating in the band 1 164-1 215 MHz
Recommendation ITU-R M.1906-1	Characteristics and protection criteria of receiving space stations and characteristics of transmitting earth stations in the radionavigation-satellite service (Earth-to-space) operating in the band 5 000-5 010 MHz
Recommendation ITU-R M.2030-0	Evaluation method for pulsed interference from relevant radio sources other than in the radionavigation-satellite service to the radionavigation-satellite service systems and networks operating in the 1 164-1 215 MHz, 1 215-1 300 MHz and 1 559-1 610 MHz frequency bands
Recommendation ITU-R M.2031-1	Characteristics and protection criteria of receiving earth stations and characteristics of transmitting space stations of the radionavigation-satellite service (space-to-Earth) operating in the band 5 010-5 030 MHz
Report ITU-R M.2220-1	Calculation method to determine aggregate interference parameters of pulsed RF systems operating in and near the frequency bands 1 164-1 215 MHz and 1 215-1 300 MHz that may impact radionavigation-satellite service airborne and ground-based receivers operating in those bands
Report ITU-R M.2458-0	Radionavigation-satellite service applications in the 1 164-1 215 MHz, 1 215-1 300 MHz, and 1 559-1 610 MHz frequency bands
Report ITU-R M.2496	Use of RNSS receiver characteristics in assessment of interference from pulsed sources in the 1 164-1 215 MHz, 1 215-1 300 MHz and 1 559-1 610 MHz frequency bands

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;

g) that Report ITU-R M.2220 provides a calculation method to determine aggregate interference parameters of pulsed RF systems operating in and near the frequency bands 1 164-1 215 MHz and 1 215-1 300 MHz that may impact radionavigation-satellite service airborne and ground-based receivers operating in those bands;

h) that Report ITU-R M.2458 describes RNSS applications in the 1 164-1 215 MHz, 1 215-1 300 MHz and 1 559-1 610 MHz frequency bands;

i) that Report ITU-R M.2496 provides information on RNSS receiver front-end characteristics, including the appropriate usage of these parameters in interference evaluations, and also provides the associated consideration of pulsed interference models for RNSS receivers,

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*

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[1] 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 carrier phase obtained from L1 C/A[2] 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[3]. 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, column 1. Since the receiver uses L1 C/A

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

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.

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, 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.

2.2.2 L2C-transitional high-precision semi-codeless receivers

This receiver has all the characteristics of the high-precision semi-codeless receiver in § 2.2.1 and also acquires and tracks the new L2C signal[4] 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, column 2 still apply.

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

2.3 High-precision receivers

The high-precision category represents RNSS receivers that are used within the scope of this Recommendation in applications requiring high positioning accuracy (e.g. surveying, scientific, and agricultural applications). High-precision receivers use various techniques (e.g. semi-codeless techniques) to acquire and track RNSS signals in two or three RNSS frequency bands for carrier phase ambiguity resolution and require protection in all bands used. The characteristics and protection levels for high-precision receivers also apply to RNSS receivers that are designed to operate in specialized RNSS applications (e.g. single-frequency ground networks and precision navigation).

High-precision RNSS receivers and receivers designed to operate in specialized RNSS applications also can operate in stressed environments (e.g. under foliage). Two receiver types are listed in Table 1, column 3 and column 3a; each of which uses a different RNSS satellite signal type (either for the L2C signal; or for the B3 and B3A signals).

The first 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, 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 also apply.

The second receiver type is a ground-based receiver that will acquire and track the B3 and B3A signals[5]. Characteristics and protection criteria for this receiver type are specified in Table 1, column 3a.

2.4 High-accuracy and authentication receivers using E6-BC and L6

This receiver type is a ground-based receiver that will track the E6-BC signal. The function of this receiver is to track either or both the wide-band E6-B (data) and E6-C (pilot) signal components. In the case E6-B is concerned, the receiver will also demodulate data transmitted on this signal component which provides, among other information, Precise Point Positioning (PPP) corrections. In the case E6-C is processed, the receiver will implement advanced authentication, including the decryption of the spreading code.

The characteristics of this type of receiver that processes the E6-BC signal are provided in Table 1, column 3b. Since this receiver also uses 1 559-1 610 MHz band signals (at least E1-BC for signal acquisition), it is susceptible to interference in that band[6]. Protection criteria and other characteristics

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[5] Further details of the B3 and B3A signals are found in Annex 7 (COMPASS) of Recommendation ITU-R M.1787.

[6] The E1-BC signal is in the 1 559-1 610 MHz RNSS frequency band while E6-BC signal is in the 1 215-1 300 MHz RNSS band. Further details for these signals are found in Annex 3 (Galileo) of Recommendation ITU-R M.1787.

in the 1 559-1 610 MHz band specified for the CDMA-type high-precision receiver are found in Recommendation ITU-R M.1903.

The characteristics in column 3b also cover the types of ground-based receiver for L6 signal (see Annex 4 (QZSS) of Recommendation ITU-R M.1787 for details).

2.5 Air-navigation receiver

Air-navigation refers to an airborne receiver designed for use for all phases of flight. This receiver type can use CDMA and/or FDMA RNSS signals[7] and can operate on several carrier frequencies simultaneously. Characteristics of this receiver type are specified in Table 1, column 4.

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

2.6 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. Four receiver types are listed in Table 1, column 5; each of which uses a different RNSS satellite signal type (either CDMA, for the L2C signal, or for the B3 and B3A signals; or for GLONASS signals, CDMA and/or FDMA).

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. Four receiver types are listed in Table 1, column 6; each of which uses a different RNSS satellite signal type (either CDMA, for the L2C signal, or for the B3 and B3A signals; or for GLONASS signals, CDMA and/or FDMA).

3 Pulsed[8] radio-frequency interference 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 this pulsed RFI reduces the amount of continuous RFI that the RNSS receiver can tolerate. The amount of pulsed RFI depends on the number of 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 such RFI is insignificant. Studies by two

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[7] The term 'FDMA' refers to a frequency-division multiple access modulation technique in which all the RNSS satellites use the same modulation code, but each satellite transmits on a different carrier frequency. The term 'CDMA' refers to a code-division multiple access modulation technique in which all RNSS satellite signals are transmitted on the same carrier frequency but with different modulation codes. Further signal details are contained in Annex 1 (GLONASS) and Annex 2 (GPS) of Recommendation ITU-R M.1787.

[8] Continuous interference is used here to mean interference from sources of fairly constant power that is generally present at all times. This is distinguished from pulsed interference which consists of bursts of transmission followed by periods of non-transmission. Compatibility of the latter with RNSS is a function of the burst power and duration, and the transmission duty cycle.

aviation standards organizations[9] have identified an analysis method that addresses the combined effect of pulsed and continuous RFI[10]. Two variations in the basic method were derived that depend on the type of RNSS receiver mitigation for pulsed sources: one for receivers incorporating "pulse-blanking" technology (developed for operation in environments with high duty cycle pulsed RFI); and one for more general-purpose, saturating receivers (suitable for operation in environments with low duty cycle pulsed RFI). For example, the SBAS ground reference receiver (see § 2.1) incorporates pulse-blanking technology for improved performance in the presence of pulsed RFI.

4 RNSS receiver technical characteristics and protection criteria

Table 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.

Table 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, column 1).

– High-precision semi-codeless receiver (see § 2.2.1 and Table 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 (2 types) (see § 2.3 and Table 1, column 3 and column 3a).

– High-accuracy and authentication receivers using E6-BC/L6 (see § 2.4 and Table 1, column 3b).

– Air-navigation receiver (2 types) (see § 2.5 and Table 1, column 4).

– Indoor positioning (4 types) (see § 2.6 and Table 1, column 5).

– General-purpose (4 types) (see § 2.7 and Table 1, column 6).

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

10 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

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

<table>
<tr><th></th><th>1</th><th>2</th><th>3</th><th>3a</th><th colspan="2">3b</th><th colspan="2">4</th><th colspan="4">5</th><th colspan="4">6</th></tr>
<tr><th>Parameter</th><th>SBAS ground reference receiver*</th><th>High-precision semi-codeless receiver*</th><th>High-precision receiver using L2C*</th><th>High-precision receiver using B3 and B3A</th><th colspan="2">High-accuracy and authentication receiver using E6-BC/L6</th><th colspan="2">Air-navigation receiver (Note 10)</th><th colspan="4">Indoor positioning</th><th colspan="4">General purpose</th></tr>
<tr><td>Signal frequency range (MHz)</td><td>1 227.6 ± 15.345</td><td>1 227.6 ± 15.345</td><td>1 227.6 ± 15.345</td><td>1 268.52 ± 12</td><td colspan="2">1 278.75 ± 21</td><td>1 246 + 0.4375*K ± 5.11, where K = −7, …, +6 (Note 8)</td><td>1 248,06 ± 7.7</td><td>1 227.6 ± 12</td><td>1 246 + 0.4375*K ± 5.11 where K = −7, .., +6</td><td>1 248,06 ± 7.7</td><td>1 268.52 ± 12</td><td>1 227.6 ± 12</td><td>1 246 + 0.4375*K ± 5.11 where K= −7,..,+6</td><td>1 248,06 ± 7.7</td><td>1 268.52 ± 12</td></tr>
<tr><td>Maximum receiver antenna gain in upper hemisphere (dBi)</td><td>−2.0 circular (Note 3)</td><td>3.0 circular</td><td>3.0 circular</td><td>3.0 circular</td><td colspan="2">3 circular</td><td colspan="2">7 circular (Note 11)</td><td colspan="3">6</td><td>3</td><td colspan="3">6</td><td>3</td></tr>
<tr><td>Maximum receiver antenna gain in lower hemisphere (dBi)</td><td>−5.0 circular (see Note 3)</td><td>−7 linear (< 10° elev.)</td><td>−7 linear (< 10° elev.)</td><td>−7 linear (< 10° elev.)</td><td colspan="2">−6 circular (Note 15)</td><td colspan="2">−10 circular</td><td colspan="3">6 (Note 12)</td><td>−9</td><td colspan="3">6 (Note 12)</td><td>−10</td></tr>
<tr><td>RF filter 3 dB bandwidth (MHz)</td><td>24.0</td><td>24.0</td><td>24.0</td><td>24.0</td><td>40.92 (Note 18)</td><td>42.0 (Note 18)</td><td colspan="2">30</td><td>32</td><td colspan="2">30</td><td>24</td><td>32</td><td colspan="2">30</td><td>24</td></tr>
<tr><td>Pre-correlation filter 3 dB bandwidth (MHz)</td><td>20.46</td><td>20.46</td><td>20.46</td><td>20.46</td><td>40.92 (Note 18)</td><td>42.0 (Note 18)</td><td>20</td><td>25</td><td>2</td><td>20</td><td>25</td><td>20.46</td><td>2</td><td>20</td><td>25</td><td>20.46</td></tr>
<tr><td>Receiver system noise temperature (K)</td><td>513</td><td>513</td><td>513</td><td>513</td><td>722 (Note 18)</td><td>645 (Note 18)</td><td colspan="2">400</td><td colspan="3">645</td><td>330</td><td colspan="3">645</td><td>330</td></tr>
<tr><td colspan="17">Thresholds for continuous interference</td></tr>
<tr><td>Tracking mode threshold power level of aggregate narrow-band interference at the passive antenna output (dBW)</td><td>−137.5 (P(Y)) (Note 1)</td><td>−137.4 (P(Y)) (Note 1)</td><td>−151.4 (Note 1)</td><td>−157.4 (Note 2)</td><td colspan="2">−134.5 (Note 16)</td><td colspan="2">−149 (Note 1) (Note 9)</td><td colspan="3">−193 (Note 1)</td><td>−193 (Note 2)</td><td colspan="3">−158 (Note 1)</td><td>−150 (Note 2)</td></tr>
</table>

TABLE 1 (*continued*)

	1	2	3	3a	3b	4	5		6	
Parameter	**SBAS ground reference receiver***	**High-precision semi-codeless receiver***	**High-precision receiver using L2C***	**High-precision receiver using B3 and B3A**	**High-accuracy and authentication receiver using E6-BC/L6**	**Air-navigation receiver (Note 10)**	**Indoor positioning**		**General purpose**	
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)	−157.4 (Note 2)	See Note 17	−155 (Note 1) (Note 9)	−199 (Note 1)	−199 (Note 2)	−164 (Note 1)	−156 (Note 2)
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)	−147.4 (Note 2)	−140 (Note 16)	−140 (Note 1) (Note 9)	−150 (Note 1)	−145 (Note 2)	−139 (Note 1)	−140 (Note 2)
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)	−147.4 (Note 2)	See Note 17	−146 (Note 1) (Note 9)	−156 (Note 1)	−151 (Note 2)	−145 (Note 1)	−146 (Note 2)
Thresholds for pulsed interference (see Note 14)										
Receiver input saturation level (dBW) (Note 14)	−135.0 (Note 6) (Note 13)	−120 (Note 6)	−120 (Note 6)	−120 (Note 6)	−120 (Note 6)	−80	−70	−100	−70	−100
Receiver survival level (dBW) (Note 14)	−10.0 (Note 7)	–20	–20	–20	–20	−1	−20	−17	−20	−17

TABLE 1 (*end*)

	1	2	3	3a	3b	4	5	6
Parameter	**SBAS ground reference receiver***	**High-precision semi-codeless receiver***	**High-precision receiver using L2C***	**High-precision receiver using B3 and B3A**	**High-accuracy and authentication receiver using E6-BC/L6**	**Air-navigation receiver (Note 10)**	**Indoor positioning**	**General purpose**
Overload recovery time (s) (Note 14)	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	$(1 \text{ to } 30) \times 10^{-6}$	30×10^{-6}	30×10^{-6}

Notes to Table 1:

* These 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.

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 and CDMA (carrier frequency 1 248.06 MHz) signals 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/CDMA (carrier frequency 1 248.06 MHz)) 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. Thresholds for interference bandwidths between 700 Hz and 1 MHz may require further study.

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 5° elevation.

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: These receiver input saturation levels apply over the corresponding RF filter 3-dB bandwidth.

Note 7: This 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 fc (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 −5.5 dBic.

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.

Note 13: This receiver input saturation level is for power in a 1 MHz bandwidth.

Note 14: The values in these rows are to be used for assessment of interference from pulsed sources in conjunction with the methodology

Note 15: The maximum lower hemisphere gain value applies for 5 degrees elevation angle.

Notes to Table 1 (end):

Note 16: Narrow-band continuous interference is considered to have a bandwidth less than 128 kHz. Wideband continuous interference is considered to have a bandwidth greater than 1 MHz. Thresholds for interference with a bandwidth between 128 kHz and 1 MHz may require further study.

Note 17: For E6-BC, signal acquisition is performed using the E1-BC signal. See the appropriate acquisition threshold row in Recommendation ITU-R M.1903 Annex 2, Table 2-2, "High-precision" column. For L6 signal, some receivers perform signal acquisition using the signals in L1 band and other receivers are expected to have 6 dB smaller threshold for the acquisition mode than for the tracking mode.

Note 18: Bandwidth of 40.92 MHz is for E6-BC receiver and that of 42.0 MHz is for L6 receiver. Noise temperature of 722 K is for E6-BC receiver and that of 645 K is for L6 receiver.