RECOMMENDATION ITU-R M.1479

TECHNICAL CHARACTERISTICS AND PERFORMANCE REQUIREMENTS OF CURRENT AND PLANNED RADIONAVIGATION-SATELLITE SERVICE (SPACE-TO-SPACE) RECEIVERS TO BE CONSIDERED IN INTERFERENCE STUDIES IN THE FREQUENCY BANDS 1 215-1 260 MHz AND 1 559-1 610 MHz

(Question ITU-R 219/8)

(2000)

The ITU Radiocommunication Assembly,

considering

a) that WRC-2000 agenda item 1.15.2 invites consideration of the addition of the space-to-space direction to the radionavigation-satellite service (RNSS) allocation in the bands 1 215-1 260 MHz and 1 559-1 610 MHz;

b) that the frequency bands 1 215-1 260 MHz and 1 559-1 610 MHz are allocated on a primary basis to the RNSS in the space-to-Earth direction;

c) that the 1 215-1 260 MHz band is also allocated to the radiolocation service on a primary basis and to the Earth exploration-satellite (EESS) (active), and space research (SRS) (active) services on a primary basis subject to RR No. S5.332 and the 1 559-1 610 MHz band is also allocated to the aeronautical radionavigation service (ARNS) on a primary basis;

d) that the 1 215-1 260 MHz band is also allocated on a primary basis to the fixed and mobile services in some countries (RR No. S5.330) and to the radionavigation service in some countries (RR No. S5.331) and the 1 559-1 610 MHz band is also allocated to the fixed service on a primary basis in some countries (RR No. S5.359) and on a secondary basis in other countries (RR No. S5.355);

e) that spaceborne receivers of the RNSS, making use of existing RNSS (space-to-Earth) transmissions, are already in operation on a non-protected basis, or are planned for operation on spacecraft used for mobile satellite, Earth exploration, space research, and manned space applications;

f) that the global orbiting navigation satellite system (GLONASS) is a system of the RNSS that operates in the 1 215-1 260 MHz and 1 559-1 610 MHz bands and that spaceborne receivers have been constructed and are intended to be used in the space-to-space direction for spacecraft navigation;

g) that GPS is a system of the RNSS that also operates in the 1 215-1 260 MHz and 1 559-1 610 MHz bands and is being used in the space-to-space direction for spacecraft navigation;

h) that E-NSS-1 and MSATNAV are planned RNSS systems that will also operate in the above frequency bands and may provide spacecraft radionavigation;

j) that use of RNSS space-to-Earth emissions in the 1 215-1 260 MHz and 1 559-1 610 MHz bands for space navigation represents an efficient use of the spectrum and does not change the interference environment experienced by other services;

k) that Recommendation ITU-R M.1088 provides information on the GPS system; Recommendation ITU-R M.1317 provides information on the GLONASS system and Recommendation ITU-R M.1477 provides information on technical and performance characteristics of RNSS receivers for the GPS, GLONASS, E-NSS-1 and MSATNAV systems,

recommends

1 that the spaceborne radionavigation receiver characteristics and performance requirements presented in the Annexes be used in interference studies between RNSS (space-to-space) and other radiocommunication services.

NOTE 1 – The nomenclatures L1 and L2 are used consistently within GLONASS in Annex 1, GPS in Annex 2 and MSATNAV in Annex 4 but refer to different specific parts of the L1 band, 1 559-1 610 MHz, and the L2 band, 1 215-1 260 MHz, as quoted in the frequency ranges specified in these different Annexes;

2 that the permissible interference power spectral densities given in the Annexes may be used in interference calculations for spaceborne radionavigation receivers in low-Earth orbit (LEO);

3 that the C/N_0 requirements given in the Annexes together with other characteristics of the RNSS systems may be used in interference calculations for spaceborne radionavigation receivers at higher altitudes;

4 that in cases where the permissible interference power spectral densities given in the Annexes is exceeded, the C/N_0 requirements given in the Annexes together with other characteristics of the RNSS systems may be used in interference calculations for spaceborne radionavigation receivers in LEO.

ANNEX 1

GLONASS spaceborne receiver characteristics

Table 1 provides characteristics of spaceborne receivers for use with the GLONASS system.

TABLE 1

Parameter	GLONASS
Frequency ranges(1) (MHz)	(1998-2005) 1 592.9575-1 614.4225 (L1) 1 237.8275-1 256.7975 (L2) (After the year 2005) 1 592.9575-1 610.485 (L1) 1 237.8275-1 253.735 (L2)
Carrier frequencies (MHz)	(1998-2005)(2) 1 598.0625-1 609.3125 in steps of 0.5625 MHz (L1) 1 242.9375-1 251.6875 in steps of 0.4375 MHz (L2) (After the year 2005) 1 598.0625-1 605.375 in steps of 0.5625 MHz (L1) 1 242.9375-1 248.625 in steps of 0.4375 MHz (L2)
Peudo noise code rates (Mchips/s)	5.11 (P-code on L1 and L2) 0.511 (C/A-code on L1 and L2)
Antenna coverage(3)	Hemispherical
Antenna peak gain(3) (dBi)	3-5 (L1) 0-3 (L2)
Preamplifier limiting level (μW)	0.01
Preamplifier burnout level (W)	0.8 average
Overload recovery time (ms)	1
Receiver system noise temperature(3) (K)	100-670
Receiver front end bandwidth (MHz)	22 (L1) 19 (L2)
Permitted in-band wideband interference power density at receiving antenna output (dB(W/MHz))	–140
C/N_0 performance requirement(4) (dB(Hz))	34 (tracking) 37 (acquisition)

(1) It should be noted that the frequency band above 1 610 MHz is not allocated to the RNSS (space-to-Earth).

(2) Carrier frequencies 1 604.8125 MHz and 1 605.375 MHz in the L1 band and 1 248.1875 MHz and 1 248.625 MHz in the L2 band are expected to be used as technical channels when the satellites are over Russian territory.

(3) Different spacecraft receivers may have values which differ from these typical values.

(4) Permitted C/N_0 (after signal convolution) should include receiver noise temperature, intra-channel interference and any outside interference.

ANNEX 2

GPS spaceborne receiver characteristics

Table 2 provides characteristics of spaceborne receivers for use with the GPS system. It should be noted that since the technical requirements and operational environment for spaceborne RNSS receivers differs from that for terrestrial receivers, their characteristics may be different.

TABLE 2

Parameter	GPS
Frequency ranges (MHz)	1 563.42-1 587.42 (L1) 1 215.60-1 239.60 (L2)
Carrier frequencies (MHz)	1 575.42 (L1) 1 227.60 (L2)
Pseudo noise code rates (Mchips/s)	1.023 (C/A code on L1 carrier) 10.23 (P/Y code on both L1 and L2 carriers)
Antenna coverage(1)	Hemispherical
Antenna peak gain(1) (dBi)	7
Preamplifier limiting level(2) (µW)	0.1 (–40 dBm)
Preamplifier burnout level(2) (W)	1 (30 dBm) (average) 10 (40 dBm) (peak)
Maximum tolerable pulse duty cycle for pulsed interference(3) (%)	15-35
Receiver system noise temperature(1) (K)	75
Receiver front end bandwidth(1) (MHz)	24
Receiver implementation loss + A/D converter loss(1) (dB)	2.0
C/N_0 performance requirement(4) (dB(Hz))	30.0 (tracking) 34.0 (acquisition)
Permissible total wideband interference power spectral density at antenna output (dB(W/MHz)) (receiver < 2 000 km altitude)(5)	–135
Permissible total narrow-band interference power at antenna output (dBW in 100 kHz) (receiver < 2 000 km altitude)(5)	–135

(1) Different spacecraft receivers may have values which differ from these typical values.

(2) Based on Recommendation ITU-R M.1088 – Considerations for sharing with systems of other services operating in the bands allocated to the radionavigation-satellite service. The front end of the GPS receiver is affected by interference in two ways. The first interference mechanism affects the high-level limiter diode in the RF front end. The diode will saturate and prevent burnout of the following receiver stages when the peak RF power level at the receiver input equals or exceeds –40 dBm, causing a temporary loss of signal. If the average RF power at the receiver input exceeds 1 W or peak RF power exceeds 10 W, the high-level clipper diode may fail because of burnout.

(3) The tolerable pulse duty cycle will depend on the particular pulse suppression technique and automatic gain control (AGC) design used in the receiver as well as the allowed C/N_0 degradation. For example, a pulse clipping hard limiting receiver (i.e. 1-bit A/D converter) with no AGC suffers about 2 dB C/N_0 degradation, 10 log(1 – DC)2, with 20% duty cycle (DC) while a pulse blanking receiver which detects and erases pulses can tolerate 35% DC with 2 dB C/N_0 degradation (10 log(1 – DC)).

(4) This is a post-correlation value applicable to code-phase type receivers and is the minimum signal quality required for the signal to be used in the navigation solution. The navigation solution may not necessarily include signals from all GPS satellites in view. Requirements for special types of receivers (i.e. codeless/semi-codeless) are yet to be determined. The available or actual received C/N_0 to be compared with the required values should include the receiver thermal noise, GPS co-channel interference, and any external intermittent interference (after spectrum spreading).

(5) These values are derived from the 34 dB(Hz) C/N_0 threshold for L1 C/A code acquisition and assume wanted GPS signal power levels and GPS co-channel interference levels experienced by receivers in LEO.

ANNEX 3

E-NSS-1 spaceborne receiver characteristics

Table 3 provides characteristics of radionavigation-satellite receivers for use with the planned E-NSS-1 system for spaceborne applications.

TABLE 3

Parameter	E-NSS-1
Frequency ranges (MHz)	1 587.696-1 591.788 (E1) 1 559.052-1 563.144 (E2) 1 215.068-1 215.580 (E3)
Carrier frequencies (MHz)	1 589.742 (E1) 1 561.098 (E2) 1 215.324 (E3)
Pseudo noise code rates (Mchips/s)	3.069 (on E1 and E2 carriers) 0.383625 (on E3 carrier)
Antenna coverage	Hemispherical
Antenna peak gain (zenith) (dBi)	3
Antenna minimum gain (5° elevation) (dBi)	–4.5
Receiver system noise temperature (K)	350
Minimum received signal power at antenna output (dBW)	–157.3
C/N_0 required for navigation (dB(Hz))	36.0
Permissible total wideband interference power spectral density at antenna output (dB(W/MHz)) (receiver < 3 000 km altitude)	–135
Permissible total narrow-band interference power at antenna output (dBW) (receiver < 3 000 km altitude)	–145

ANNEX 4

MSATNAV spaceborne receiver characteristics

Table 4 provides characteristics of spaceborne RNSS receivers for use with the planned MSATNAV system.

TABLE 4

Parameter	MSATNAV
Frequency bands (MHz)	(L2) 1 215.324-1 217.370 1 215.870-1 218.870 1 256.790-1 259.790 (L1) 1 559.598-1 562.598 1 588.242-1 591.242
Carrier frequencies (MHz)	(L2) 1 216.347 1 217.370 1 258.290 (L1) 1 561.098 1 589.742
Pseudo noise code rates (Mchips/s)	1.023
Antenna coverage[(1)]	Hemispherical
Antenna peak gain (zenith) (dBi)	7
Receiver system noise temperature[(1)] (K)	75
Required C/N_0[(2)] (dB(Hz))	30.0 (tracking) 34.0 (acquisition)
Permissible total wideband interference power spectral density at antenna output[(1)] (dB(W/MHz)) (receiver < 2 000 km altitude)	–135

(1) Different spacecraft receivers may have values which differ from these typical values.

(2) Total noise is composed of thermal noise, intra-system interference and external interference.