International Telecommunication Union

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Recommendation ITU-R M.1906
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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

M Series

Mobile, radiodetermination, amateur and related satellite services

International Telecommunication Union

Foreword

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P	Radiowave propagation
RA	Radio astronomy
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S	Fixed-satellite service
SA	Space applications and meteorology
SF	Frequency sharing and coordination between fixed-satellite and fixed service systems
SM	Spectrum management
SNG	Satellite news gathering
TF	Time signals and frequency standards emissions
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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.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

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

(2012)

Scope

Characteristics and protection criteria for radionavigation-satellite service (RNSS) receiving space stations, and characteristics of RNSS transmitting earth stations, planned or operating in the band 5 000-5 010 MHz are presented in this Recommendation. This information is intended for performing analyses of radio-frequency interference impact on systems and networks in the RNSS (Earth-to-space) operating in this band 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 there are various operating and planned systems and networks in the RNSS;

c) that studies are being conducted on the interference into RNSS systems and networks from other radio services;

d) that Recommendation ITU-R M.1901 provides guidance on ITU-R Recommendations related to systems and networks in the RNSS,

recognizing

a) that the band 5 000-5 010 MHz is globally allocated on a primary basis to RNSS (Earth-to-space);

b) that the band 5 000-5 010 MHz is also globally allocated on a primary basis to the aeronautical radionavigation service (ARNS);

c) that the band 5 000-5 010 MHz is also globally allocated on a primary basis to the aeronautical mobile-satellite (route) service (AMS(R)S) under No. 5.367 of the Radio Regulations (RR) subject to No. 9.21 of the RR,

recommends

1 that the characteristics and protection criteria of receiving space stations and the characteristics of transmitting earth stations given in Annexes 1, 2 and 3 should be used in performing analyses of radio-frequency interference impact on systems and networks in the RNSS (Earth-to-space) operating in the band 5 000-5 010 MHz from radio sources other than in the RNSS;

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[1] This Recommendation should be brought to the attention of ITU-R Study Group 5 and the International Civil Aviation Organization (ICAO).

2 that the allowance for interference to systems and networks in the RNSS (Earth-to-space) operating in the band 5 000-5 010 MHz from all radio sources of primary services in the band other than in the RNSS, should not exceed 6% of the RNSS receiver system noise.

Annex 1

Technical characteristics and protection criteria of receiving space stations and characteristics of transmitting earth stations of the Galileo system operating in the band 5 000-5 010 MHz

1 Introduction

This band is used by the Galileo system for the operation of feeder-link stations transmitting navigation mission information to the satellites. Through feeder links all system and navigation mission relevant information is transferred to the Galileo satellites comprising ephemerides, clock correction information, service integrity messages and all other data elements of the navigation message that require continuous updates.

The feeder link is not intended for user access. Up to 20 uplink earth stations, using the RNSS (Earth-to-space) allocation in the 5 000-5 010 MHz frequency band are operated from geographical locations worldwide to enable access to each satellite in the constellation at any time.

The system includes in its architecture:

− a space segment comprising 27 active satellites evenly distributed on three circular Earth orbits at 23 222 km altitude, each orbital plane inclined to the equator by 54° − a ground control segment providing system and satellite monitoring and control, operating on 2 GHz frequencies for satellite control (telecommand and telemetry);

− a ground mission segment that uploads data for subsequent broadcast to users of integrity messages via Galileo satellites.

The data elements for the orbit ephemerides and service integrity information are calculated from measurements determined and processed by a worldwide network of Galileo monitoring stations. One of the most critical elements is the dissemination of integrity information to user receivers in the Galileo Safety-of-Life (SoL) service. This information is provided by the 5 GHz feeder uplink signal and is specified to reach user receivers within six seconds after detection of pre-defined limits of service degradation. The SoL positioning and timing information is provided through the E5-signals.

2 Galileo feeder uplink characteristics

The parameters for typical Galileo feeder uplink earth stations are listed in Table 1-1. Transmit filtering will be implemented for all Galileo transmit signals.

TABLE 1-1

Characteristics of Galileo transmitting earth stations operating in the band 5 000-5 010 MHz

Parameter	Value
Centre frequency (MHz)	5 005
Antenna diameter (m)	3.0
Polarization	RHCP
Antenna pattern	Rec. ITU-R S.465-5
Theoretical antenna gain (dBi)	41.8
e.i.r.p. (dBW)	50.3
Modulation/coding	QPSK/spread spectrum
RF bandwidth (MHz)	10

RHCP: Right-hand circular polarization.

3 Satellite receiver characteristics

Typical characteristics for satellite receivers are listed in Table 1-2.

TABLE 1-2

Characteristics of Galileo receiving space stations operating in the band 5 000-5 010 MHz

Parameter	Value
Centre frequency (MHz)	5 005
RF bandwidth (MHz)	10
Polarization	RHCP
Antenna pattern/type	Circular horn antenna
Antenna pointing	Nadir
Maximum receive antenna gain (dBi)	12.8
Antenna half-beam width (°) (at 5° elevation angle)	12.4
Minimum elevation (°)	5
Satellite altitude (km)	23 222
Rx noise PSD (dBW/Hz)	−201
Tolerable effective I_0 (based on DT/T of 6%) (dBW/Hz)	−213.2

Annex 2

Technical characteristics and protection criteria of receiving space stations and characteristics of transmitting earth stations for the Global Positioning System operating Earth-to-space in the band 5 000-5 010 MHz

1 Introduction

The Global Positioning System (GPS) uplink and downlink feeder links will provide communications for system and satellite monitoring, commanding and control; updates of orbit ephemerides and clock synchronization. A feeder uplink in the 5 000-5 010 MHz band is being considered for future GPS modernizations as a backup for the current 2.2 GHz GPS feeder uplink. Communications for feeder links may use filtered quadrature phase-shift keying (QPSK) or other bandwidth-efficient modulation.

2 GPS feeder uplink characteristics

GPS plans estimate the operational bandwidth of the uplink to be 1.1 MHz, with a data rate of 1.1 megabits per second or less. The earth station's uplink transmit antenna is assumed to be a centre-fed circular parabolic dish, which is also assumed to be used as the downlink receive antenna for a 5 010-5 030 MHz feeder-link downlink. However, due to the fact that the 5 000-5 010 MHz Earth-to-space and 5 010-5 030 MHz space-to-Earth bands are adjacent, simultaneously using both uplink and downlink feeder links with a single GPS space station would require further research. The most likely solution is the implementation of satellite filters with very sharp cut-offs. However, at this point, studies have not concluded on whether satellites should simultaneously implement 5 GHz feeder uplinks and downlinks. Further study is currently being done as designs for this and other 5 GHz RNSS systems mature.

Tables 2-1 and 2-2 provide characteristics for the GPS transmitting ground stations and characteristics and protection criteria for receiving feeder-link space stations, respectively, for operation in the band 5 000-5 010 MHz. Transmit filtering will be implemented for all GPS transmit signals. Spurious emissions are intended to be −60 dB from the peak. While these parameters are derived from and consistent with current GPS specifications, these values are still subject to change.

TABLE 2-1

GPS feeder uplink transmissions in the band 5 000-5 010 MHz

Parameter	Parameter value
Signal frequency range (MHz) (Note 1)	5 000.605 ± 0.6
Data rate (symbol/s)	2 200 000 symbol/s
Signal modulation method	Filtered QPSK
Polarization	RHCP
Ellipticity (dB)	1.5 maximum
Transmit e.i.r.p. (dBW)	66.6

NOTE 1 − Carrier frequency of the RNSS signal of interest ± half the signal bandwidth.

TABLE 2-2

Characteristics and protection criteria of GPS receiving space stations operating in the band 5 000-5 010 MHz

Parameter	Parameter value
Antenna diameter (m)	0.150
Polarization	RHCP
Antenna pattern	Centre-fed circular parabolic dish
Theoretical antenna gain (dBi)	17.91
Antenna efficiency loss (dB)	4.00
Maximum polarization mismatch loss (dB)	0.31
Maximum receive antenna gain (dBi)	13.60
Satellite receiver system noise temperature (K)	590
Minimum elevation (degree)	5.0
Satellite altitude (km)	20 200

Annex 3

Technical characteristics and protection criteria of receiving space stations and the characteristics of transmitting earth stations of the Quasi-Zenith Satellite System operating in the band 5 000-5 010 MHZ

1 Introduction

The Quasi-Zenith Satellite System (QZSS) uplink and downlink feeder links provide communications for system and satellite monitoring, command, control and navigation message upload. The QZSS control stations are located in the Asia-Pacific Region.

2 QZSS characteristics

QZSS satellites include RNSS payloads operating in both the 5 000-5 010 MHz band (satellite receivers) and the 5 010-5 030 MHz band (satellite transmitters). Due to the fact that these bands are adjacent, a self-interference mitigation technique is implemented in the QZSS satellites' payload in order to avoid self-interference. Furthermore, only the lower portion of the 5 000-5 010 MHz uplink frequency band and the upper portion of the 5 010-5 030 MHz downlink frequency band are used by QZSS.

The QZSS feeder uplink in the 5 000-5 010 MHz band includes command, navigation message upload and ranging functions.

For evaluation of potential interference to the QZSS command link and navigation message upload link, the characteristics in Tables 3-1 and 3-2 should be used.

For interference evaluation of the ranging link, the characteristics and protection criteria should be exchanged in bilateral discussions as in the usual practice for satellite inter-system frequency coordination. This is because proper assessment of any interference impact to the QZSS ranging link requires overall C/N_0 evaluation taking into account the uplink and downlink segments. (It is not possible to evaluate the QZSS ranging link performance based only on interference to the uplink.)

TABLE 3-1

Characteristics of QZSS transmitting earth stations operating in the band 5 000-5 010 MHz

Parameter	Parameter value
Maximum antenna gain	49.0 dBi
Antenna pattern	Rec. ITU-R S.465-5
Polarization	LHCP
Transmit e.i.r.p. (dBW)	61.4/56.1 for command 60.4/55.4 for navigation message upload
Modulation	PCM-PSK/PM

LHCP: Left-hand circular polarization.

TABLE 3-2

Characteristics and protection criteria of QZSS receiving space stations operating in the band 5 000-5 010 MHz

Parameter	Parameter value
Antenna pattern	Global beam
Necessary bandwidth (kHz)	400
Noise temperature (K)	400
Satellite gain (dBi)	Maximum: 16.8 Minimum: 8.0 (including feeder loss)
Minimum satellite altitude (km)	31 600

NOTE − Tables 3-1 and 3-2 only contain the characteristics of the QZSS command and navigation upload links. The paragraph preceding Table 3-1 should be referenced regarding the characteristics and protection criteria of the QZSS ranging link.