International Telecommunication Union



Recommendation ITU-R M.1906-1 (09/2015)

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



Foreword

The role of the Radiocommunication Sector is to ensure the rational, equitable, efficient and economical use of the radio-frequency spectrum by all radiocommunication services, including satellite services, and carry out studies without limit of frequency range on the basis of which Recommendations are adopted.

The regulatory and policy functions of the Radiocommunication Sector are performed by World and Regional Radiocommunication Conferences and Radiocommunication Assemblies supported by Study Groups.

Policy on Intellectual Property Right (IPR)

ITU-R policy on IPR is described in the Common Patent Policy for ITU-T/ITU-R/ISO/IEC referenced in Annex 1 of Resolution ITU-R 1. Forms to be used for the submission of patent statements and licensing declarations by patent holders are available from <u>http://www.itu.int/ITU-R/go/patents/en</u> where the Guidelines for Implementation of the Common Patent Policy for ITU-T/ITU-R/ISO/IEC and the ITU-R patent information database can also be found.

	Series of ITU-R Recommendations
	(Also available online at <u>http://www.itu.int/publ/R-REC/en</u>)
Series	Title
BO	Satellite delivery
BR	Recording for production, archival and play-out; film for television
BS	Broadcasting service (sound)
BT	Broadcasting service (television)
F	Fixed service
Μ	Mobile, radiodetermination, amateur and related satellite services
Р	Radiowave propagation
RA	Radio astronomy
RS	Remote sensing systems
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
V	Vocabulary and related subjects

Note: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.

Electronic Publication Geneva, 2015

© ITU 2015

All rights reserved. No part of this publication may be reproduced, by any means whatsoever, without written permission of ITU.

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)

(2012-2015)

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 radiofrequency interference impact on systems and networks in the RNSS (Earth-to-space) operating in this band from radio sources other than in the RNSS.

Keywords

RNSS, protection criteria, radiofrequency interference impact

Abbreviations/Glossary

QPSK Quadrature phase-shift keying

SoL Safety-of-Life

UQPSK Unbalanced quadrature phase-shift keying

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.1787-2 Description of systems and networks in the radionavigationsatellite 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.1831-1 A coordination methodology for RNSS inter-system interference estimation

- Recommendation ITU-R M.1901-1 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.1902-0 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

Recommendation ITU-R M.1903-0	Characteristics	and	protection	criteria	for	receiving	g earth
	stations in the ra	adion	avigation-sa	tellite se	rvice	e (space-to	-Earth)
	and receivers	in t	he aeronau	tical rac	liona	vigation	service
	operating in the band 1 559-1 610 MHz						

Recommendation ITU-R M.1904-0 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.1905-0 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.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

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 in 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,

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 $5\,000-5\,010\,\text{MHz}$ 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 RR;

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

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;

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.

Rec. ITU-R M.1906-1

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

Parameter	Parameter value		
Signal frequency range (MHz) (Note 1)	$5\ 000.605\pm 0.6$		
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		

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

NOTE 1 – Carrier frequency of the RNSS signal of interest \pm half the signal bandwidth.

Rec. ITU-R M.1906-1

TABLE 2-2

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			

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

Annex 3

Technical characteristics and protection criteria of receiving space stations and the characteristics of transmitting earth stations of the Quasi-Zenith Satellite System (QZSS) 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.

The QZSS feeder uplink in the 5 000-5 010 MHz band includes command, navigation message upload and ranging functions. Multiple navigation upload links on a single RF carrier frequency will be implemented for each QZSS satellite, except for the first QZSS satellite.

For evaluation of potential interference to the QZSS command link and navigation message upload link, the characteristics in Tables 3-1, 3-2, 3-3 and 3-4 should be used.

Rec. ITU-R M.1906-1

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/No 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 (for the first QZSS satellite) 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
Minimum transmit e.i.r.p. (dBW)	56.1 for command 55.4 for navigation message upload
Modulation	PCM-PSK/PM

LHCP: Left-hand circular polarization

TABLE 3-2

Characteristics of QZSS transmitting earth stations (for subsequent satellites) operating in the band 5 000-5 010 MHz

Parameter	Parameter value		
Maximum antenna gain	51.0 dBi		
Antenna pattern	Rec. ITU-R S.465-5		
Polarization	LHCP		
Minimum transmit e.i.r.p. per channel (dBW)	48.3 for command		
	53.3 for navigation message upload		
Modulation	UQPSK		

LHCP: Left-hand circular polarization

UQPSK: Unbalanced Quadrature Phase Shift Keying – A QPSK modulation employing different rates, powers and/or data formats between I-channel and Q-channel.

TABLE 3-3

Characteristics and protection criteria of QZSS receiving space stations (for the first QZSS satellite) 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 to 3-4 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.

TABLE 3-4

Characteristics and protection criteria of QZSS receiving space stations (for subsequent satellites) operating in the band 5 000-5 010 MHz

Parameter	Parameter value	
Antenna pattern	Global beam	
Necessary bandwidth (kHz)	10 000	
Noise temperature (K)	300	
Satellite gain (dBi)	Maximum: 16.8 Minimum: 8.0 (including feeder loss)	
Minimum satellite altitude (km)	31 600	

NOTE – Tables 3-1 to 3-4 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.