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| **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** |

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.

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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 <http://www.itu.int/ITU-R/go/patents/en> 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.

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| Series of ITU-R Recommendations  (Also available online at <http://www.itu.int/publ/R-REC/en>) | |
| **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 |
| M | Mobile, radiodetermination, amateur and related satellite services |
| **P** | 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 |

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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)

(2012-2015)

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

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| --- | --- |
| 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 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.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 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.1904-0 | 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 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.

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 (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.

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. | |

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