



Recommendation ITU-R M.1901-3
(01/2022)

**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**

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.

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 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.

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

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

Electronic Publication
Geneva, 2022

© ITU 2022

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

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**

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

(2012-2013-2019-2022)

Scope

This Recommendation provides guidance on ITU-R Recommendations and Reports related to the technical characteristics and protection criteria of radionavigation-satellite service (RNSS) receiving earth stations and characteristics of RNSS transmitting space stations planned or 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. In addition, this Recommendation gives a brief overview of those Recommendations and Reports.

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.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
- 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 there are several operating and planned systems and networks in the RNSS;

c) that any properly equipped earth station may receive navigation information from systems and networks in the RNSS on a worldwide basis,

noting

a) that Recommendations ITU-R M.1905, ITU-R M.1902, ITU-R M.1903 and ITU-R M.1904 provide technical and operational characteristics of, and protection criteria for, system and network receivers (space-to-Earth and space-to-space) in the RNSS in the bands 1 164-1 215 MHz, 1 215-1 300 MHz and 1 559-1 610 MHz;

b) that Recommendation ITU-R M.1906 provides technical and operational characteristics and protection criteria of receiving space stations and characteristics of transmitting earth stations in the RNSS (Earth-to-space) operating in the band 5 000-5 010 MHz;

c) that Recommendation ITU-R M.2031 provides technical and operational characteristics and protection criteria of receiving earth stations and characteristics of transmitting space stations in the RNSS (space-to-Earth) operating in the band 5 010-5 030 MHz;

d) that Recommendation ITU-R M.1787 provides technical descriptions of systems and networks in the RNSS (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;

e) that Recommendation ITU-R M.1318 provides a model for evaluating interference from environmental sources into RNSS receivers operating in the bands 1 164-1 215 MHz, 1 215-1 300 MHz, 1 559-1 610 MHz and 5 010-5 030 MHz;

f) that Recommendation ITU-R M.2030 provides “an evaluation method for pulsed interference from relevant radio sources other than in the RNSS to the RNSS systems and networks operating in the 1 164-1 215 MHz, 1 215-1 300 MHz and 1 559-1 610 MHz bands”;

g) that Recommendation ITU-R M.1831 provides a methodology for RNSS intersystem interference estimation to be used in coordination among systems and networks in the RNSS;

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.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;

j) 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,

recommends

that Annex 1 should be used as guidance on ITU-R Recommendations associated with systems and networks in the RNSS operating in the 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.

Annex 1

1 List of Recommendations relating to RNSS

ITU-R Recommendations providing technical characteristics and protection criteria of systems and networks in the RNSS are listed in Table 1. Where a particular RNSS system is considered, some Recommendations provide details of that system in a separate annex while others have a common annex.

TABLE 1

**ITU-R Recommendations on RNSS system characteristics and protection criteria
in the 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**

Band(s) (MHz)	Types of stations	Rec. ITU-R	Title
1 164-1 215	User receiver	M.1905	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
1 215-1 300	User receiver	M.1902	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
1 559-1 610	User receiver	M.1903	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
5 010-5 030	User receiver; Earth station receiver	M.2031	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
5 000-5 010	Satellite receiver	M.1906	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
1 164-1 215 1 215-1 300 1 559-1 610	Space-borne user receiver	M.1904	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
1 164-1 215 1 215-1 300 1 559-1 610	Satellite transmitter	M.1787	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

Table 2 lists the ITU-R Recommendations which provide models for:

- 1) evaluation of continuous and pulsed (see Note 3 to Table 3) interference to RNSS receivers from non-RNSS radio sources; and
- 2) evaluation of intersystem RNSS interference for the purpose of coordination among systems and networks in the RNSS.

TABLE 2

ITU-R Recommendations on RNSS methods for evaluating interference to RNSS systems in the bands 1 164-1 215 MHz, 1 215-1 300 MHz, 1 559-1 610 MHz and 5 010-5 030 MHz

Bands (MHz)	Types of stations	Rec. ITU-R	Title
1 164-1 215 1 215-1 300 1 559-1 610 5 010-5 030	All	M.1318	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
1 164-1 215 1 215-1 300 1 559-1 610 5 010-5 030	All	M.2030	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
1 164-1 215 1 215-1 300 1 559-1 610 5 010-5 030	All	M.1831	A coordination methodology for RNSS inter-system interference estimation

2 Parameters relevant to the assessment of interference to RNSS systems

RNSS system parameters relevant to the assessment of interference from radio sources other than in the RNSS are listed in Table 3. Certain RNSS signal parameters are not shown but are contained in Recommendation ITU-R M.1787.

TABLE 3

RNSS parameter descriptions relevant to Recommendations ITU-R M.1905, ITU-R M.1902, ITU-R M.1903, ITU-R M.1904 and ITU-R M.2031 (see Note 1)

Parameter	RNSS parameter description
Signal frequency range (MHz)	Frequency range of the RNSS signal of interest. For CDMA systems: carrier frequency \pm half the signal bandwidth (unless otherwise noted); for FDMA systems: base frequency + (channel number * channel spacing) \pm half the signal bandwidth. Channel number range should also be given.
Maximum receiver antenna gain in upper hemisphere (dBi)	Maximum receiver antenna gain in upper hemisphere with the specified polarization.
Maximum receiver antenna gain in lower hemisphere (dBi)	Maximum receiver antenna gain in lower hemisphere with the specified polarization.
RF filter 3 dB bandwidth (MHz)	Bandwidth between the 3 dB down points of the receiver's front-end RF bandpass filter.
Pre-correlation filter 3 dB bandwidth (MHz)	Bandwidth between the 3 dB down points of the receiver's IF bandpass filter (just prior to the correlator).
Receiver system noise temperature (K)	Combination of receiver equivalent input noise temperature and antenna equivalent noise temperature.

TABLE 3 (cont.)

Parameter	RNSS parameter description
Thresholds for continuous interference (see Note 2)	
Tracking mode threshold power level of aggregate narrow-band interference at the passive antenna output (dBW)	The minimum narrow-band interference power level (referenced to the passive antenna output and within the RF filter bandwidth) at which the receiver loses track of a desired signal at the specified minimum received power level with a specific probability (i.e. cannot remain in track mode with the corresponding probability). This assumes the receiver had already acquired the desired signal and was tracking until the point at which the interference exceeds this threshold and the receiver fails to track properly (e.g. navigation data can no longer be properly demodulated). (See Note 3)
Acquisition mode threshold power level of aggregate narrow-band interference at the passive antenna output (dBW)	The minimum narrow-band interference power level (referenced to the passive antenna output and within the RF filter bandwidth) at which the receiver cannot acquire a desired signal at the specified minimum received power level with a specified probability and within a specified time period (i.e. cannot acquire an available signal with the corresponding probability). Note that this interference level is lower than that for the previous (tracking mode) parameter. (See Note 3)
Tracking mode threshold power density level of aggregate wideband interference at the passive antenna output (dB(W/MHz))	The minimum wideband interference power density level (referenced to the passive antenna output and within the RF filter bandwidth) at which the receiver loses track of a desired signal at the specified minimum received power level with a specified probability (i.e. cannot remain in tracking mode with the corresponding probability). This assumes the receiver has already acquired the desired signal and was tracking until the point at which the interference exceeds this threshold and the receiver fails to track properly (e.g. navigation data can no longer be properly demodulated). For purposes of determining this value, assume the aggregate interference is white Gaussian noise over the entire pre-correlation filter 3 dB bandwidth. (See Note 3)
Acquisition mode threshold power density level of aggregate wideband interference at the passive antenna output (dB(W/MHz))	The minimum wideband interference power density level (referenced to the passive antenna output and within the RF filter bandwidth) at which the receiver cannot acquire a desired signal at the specified minimum received power level with a specified probability and within a specified time period (i.e. cannot acquire an available signal with the corresponding probability). Note that this interference level is lower than that for the previous (tracking mode) parameter. For purposes of determining this value, assume the aggregate interference is white Gaussian noise over the entire pre-correlation filter 3 dB bandwidth. (See Note 3)

TABLE 3 (*end*)

Parameter	RNSS parameter description
Thresholds for pulsed interference (<i>see Notes 2 and 4</i>)	
Receiver input saturation level (dBW) (<i>see Note 4</i>)	The minimum power level at the output of the receiver's passive antenna, from pulsed sources, at which either the receiver linear gain is compressed or the receiver is saturated at any point in the receiver processing circuitry from the first gain stage through the analogue-to-digital converter.
Receiver survival level (dBW) (<i>see Note 4</i>)	The maximum power level at the output of the receiver's passive antenna, from pulsed sources, at which the receiver must survive without component failure.
Overload recovery time (s) (<i>see Note 4</i>)	The maximum time duration for the receiver to return to a steady-state transfer function performance after interference from pulsed sources exceeding the receiver input saturation level drops below that level.

Note 1: For the referenced Recommendations, parameter units should be the same as given in the Table unless explicitly noted otherwise.

Note 2: 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.

Note 3: The bandwidths of narrow-band continuous interference and wideband continuous interference are provided in Recommendations ITU-R M.1905, ITU-R M.1902, ITU-R M.1903, ITU-R M.1904 and ITU-R M.2031.

Note 4: The values supplied for these parameters are to be used for assessment of interference from pulsed sources in conjunction with Recommendation ITU-R M.2030.