



**Recommendation ITU-R S.1899**  
(01/2012)

**Protection criteria and interference  
assessment methods for non-GSO  
inter-satellite links in the  
23.183-23.377 GHz band with respect  
to the space research service**

**S Series**  
**Fixed-satellite service**

## Foreword

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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 S.1899

**Protection criteria and interference assessment methods for non-GSO inter-satellite links in the 23.183-23.377 GHz band with respect to the space research service**

(2012)

**Scope**

Links in the inter-satellite service (ISS) are used by some systems to interconnect two or more non-GSO satellites together. This Recommendation presents protection criteria and interference assessment methods for such non-GSO ISS links in the 23.183-23.377 GHz band with respect to the space research service (SRS).

The ITU Radiocommunication Assembly,

*considering*

- a) that the band 22.55-23.55 GHz is allocated on a co-primary basis to the inter-satellite, fixed and mobile services;
- b) that ISS links of non-GSO systems connect satellites providing service in other mobile satellite and fixed satellite bands;
- c) that the band is also shared by systems in the fixed service and other ISS links connecting satellites in the space research service;
- d) that methods exist for analysing the interference from other systems operating in the band allocated to non-GSO ISS links;
- e) that some operational non-GSO systems use ISS links,

*recommends*

- 1** that the aggregated unwanted emission levels in the band 23.183-23.377 GHz due to earth stations in the space research service operating in the band 22.55-23.15 GHz should not exceed a power density of  $-155$  dBW/MHz at the input to a non-GSO ISS satellite receiver, for a fraction of time greater than  $10^{-2}$  per cent (0.01%);
- 2** that the factors described in Annex 2 should be used to evaluate unwanted emission levels into the non-GSO system from space research service systems in the allocation;
- 3** that the following Note should be considered as part of this Recommendation.

NOTE – A type of system that requires protection and operates in the band 23.183-23.377 GHz is described in Annex 1.

## Annex 1

**General system characteristics of an operational non-GSO system  
using inter-satellite links in the range 23.183-23.377 GHz**

At least one non-GSO satellite communication system uses the ISS links in the 22.55-23.55 GHz band. The major characteristics of an operating constellation are presented in Table A. Its orbital configuration is described in Table B.

Due to the cross-linked nature of the satellite constellation in providing end-to-end services, the channel usage and loading distribution is non-uniform and difficult to characterize at any given time and location.

TABLE A  
System specifications

System parameter	Value
Number of satellite planes	6
Number of satellites per plane	11
Nominal altitude (km)	780
Orbit type	Circular polar (inclination angle of 86.5°)
Orbital period (min)	100
Frequency range (GHz)	23.183-23.377
Necessary bandwidth for 8 channels	8 × 19 MHz channels (total bandwidth 194 MHz) The necessary bandwidth for one channel is 19 MHz The channel spacing equals 25 MHz
Satellite system noise temperature (K)	877
Peak transmitter power (per 19 MHz channel) (dBW)	3
Antenna gain (one antenna per channel) (dBi)	36.6
e.i.r.p. (one single 19 MHz channel) (dBW)	39.6

TABLE B

Argument of latitude for satellites in the system in Table A

Plane 1 Right ascending node $\Omega = 0^\circ$		Plane 2 Right ascending node $\Omega = 31.6^\circ$		Plane 3 Right ascending node $\Omega = 63.2^\circ$	
Satellite	Arg. of latitude (degrees)	Satellite	Arg. of latitude (degrees)	Satellite	Arg. of latitude (degrees)
1	100.8	12	83.1	23	98.2
2	68.0	13	50.4	24	65.4
3	35.3	14	17.7	25	32.7
4	2.6	15	344.9	26	360.0
5	329.9	16	312.2	27	327.3
6	297.1	17	279.5	28	294.5
7	264.4	18	246.7	29	261.8
8	231.7	19	214.0	30	229.1
9	199.0	20	181.3	31	196.4
10	166.2	21	148.6	32	163.6
11	133.5	22	115.8	33	130.9
Plane 4 Right ascending node $\Omega = 94.8^\circ$		Plane 5 Right ascending node $\Omega = 126.4^\circ$		Plane 6 Right ascending node $\Omega = -22.1^\circ$	
Satellite	Arg. of latitude (degrees)	Satellite	Arg. of latitude (degrees)	Satellite	Arg. of latitude (degrees)
34	80.5	45	95.6	56	77.9
35	47.8	46	62.9	57	45.2
36	15.1	47	30.1	58	12.5
37	342.3	48	357.4	59	339.7
38	309.6	49	324.7	60	307.0
39	276.9	50	291.9	61	274.3
40	244.1	51	259.2	62	241.5
41	211.4	52	226.5	63	208.8
42	178.7	53	193.8	64	176.1
43	146.0	54	161.0	65	143.4
44	113.2	55	128.3	66	110.6



## Annex 2

### Factors in protection criteria

#### 1 Potential sources of interference

The ISS shares the allocation 22.55-23.55 GHz with the fixed and mobile co-primary services. The addition of services such as the space research service opens the possibility of additional sources of interference and prompts the interest in establishing protection criteria for the ISS.

#### 2 Protection criteria

For studies of out-of-band interference from proposed SRS uplinks operating in 22.55-23.15 GHz into the non-GSO system described in Annex 1 that uses inter-satellite links (ISL) operating in the 23.183-23.377 GHz band, the protection criteria of  $I/N = -16$  dB not to be exceeded more than 0.01% of the time at the input to each ISL receiver taking into account the aggregated effect of all SRS earth stations in operation in the 22.55-23.15 GHz band would be used. An  $I/N = -16$  dB corresponds to an  $I_0 = -155$  dB(W/MHz), derived from the system noise temperature given in Table A.

Recognizing that this non-GSO system shares its ISS spectrum with other services, the above criterion does not apply now or in the future to the existing service sharing arrangements for systems operating in the part of the allocation in which the ISL of this system operate. The protection criterion in Recommendation ITU-R SA.1155 applies to the existing systems with which this system shares spectrum. Furthermore, the sharing studies between SRS uplinks and non-GSO-non-GSO ISS links operating co-frequency in the band 22.55-23.15 GHz should apply the value of  $I/N = -10$  dB not to be exceeded more than 0.1% per link as set forth in Recommendation ITU-R SA.1155.

#### 3 Antenna pattern

In discussing the antenna pattern that should be used to represent the non-GSO system ISS receiving antenna in SRS interference studies two possibilities were initially considered. On the one hand, a preference was expressed for the pattern in Recommendation ITU-R F.1245 for compatibility studies with dynamic interference configurations, whereas on the other hand it was considered that the antenna pattern in Recommendation ITU-R S.672 was more appropriate when considering interference from a single interference source.

It was noted that neither pattern may, in itself, serve as fully appropriate to use in the analyses of ISS antennas for use in interference studies. It was also noted that, in determining the statistical behaviour of interference, it would be more appropriate to consider antenna patterns that reflect the oscillatory shape of real radiation patterns. This type of pattern is usually considered in situations involving multiple interference entries or in situations where the interference off-axis arrival angle at the victim receiving antenna varies in time, which is the case in question.

In consideration of the above, it was concluded that a pattern that lies between the patterns in Recommendations ITU-R F.1245 and ITU-R S.672 and that reflects the oscillatory shape of real antenna radiation patterns would most appropriately model the ISS antenna.

Therefore, the following pattern should be used for modelling the non-GSO system ISS antenna in carrying out such unwanted emission level studies:

$$G(\theta) = \begin{cases} 36.7 - 3 \left( \frac{\theta}{\theta_b} \right)^2 & ; \quad 0 < \theta \leq 3.1 \text{ degrees} \\ 17 + F(\theta) & ; \quad 3.1 < \theta \leq 6.1 \text{ degrees} \\ 36.6 - 25 \log \theta + F(\theta) & ; \quad 6.1 < \theta \leq 38.4 \text{ degrees} \\ -3 + F(\theta) & ; \quad 38.4 < \theta \leq 180 \text{ degrees} \end{cases}$$

where:

$$F(\theta) = 10 \log \left( \gamma \sin^2 \left( \frac{3\pi\theta}{2(2.58 \theta_b)} \right) + (1 - \gamma) \right)$$

with  $\theta_b = 1.2^\circ$  and  $\gamma = 0.999$

#### 4 Method

There are several appropriate methods for analysing interference from an SRS earth station into the ISS links of the subject non-GSO system. These include either analytical or dynamic computer simulation methodologies. In conducting such analyses it is necessary to consider the rapid movements of the non-GSO satellites crossing through narrow SRS uplink beams, as well as movements of the inter-planar cross link antennas of such non-GSO satellites relative to SRS earth station antenna pointing. Thus, the use of dynamic computer simulations is an appropriate method to determine the potential interference to these non-GSO satellites operating in the ISS. In addition, the analytical method in Recommendation ITU-R S.1529 is an alternative appropriate method to determine the potential interference to the ISS links of these non-GSO satellites, recognizing that the Recommendation ITU-R S.1529 method may have to be adapted, verified and validated to consider scenarios involving SRS satellite operations in non-Earth orbits.

Simulation parameters, such as the time interval between samples and total simulation times, should be chosen to guarantee reliable results. The results obtained from different methods should be compared to assess reliability. In this sense, comparison with results from the analytical method contained in Recommendation ITU-R S.1529 would be a useful technique. In particular, it can be very useful in situations involving very low probability events.