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Sharing criteria for space-to-Earth data transmission systems in the Earth exploration-satellite and meteorological satellite services using satellites in low-Earth orbit

SA Series

Space applications and meteorology

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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 SA.1027-4

Sharing criteria for space-to-Earth data transmission systems in the Earth exploration-satellite and meteorological-satellite services using satellites in low-Earth orbit

(Questions ITU-R 139/7 and ITU-R 141/7)

(1994-1995-1997-1999-2009)

Scope

This Recommendation provides sharing criteria for space-to-Earth transmissions from satellites in low-Earth orbit applying to both the Earth exploration-satellite and meteorological-satellite services.

The ITU Radiocommunication Assembly,

considering

a) that frequency bands allocated to the Earth exploration-satellite and meteorological-satellite services may be shared by several systems, including systems operating in other services;

b) that for the Earth exploration-satellite and meteorological-satellite services, Recommendation ITU-R SA.1026 specifies interference criteria for some frequency bands in the form of permissible levels of total interference to earth stations operating with satellites in low-Earth orbit;

c) that Recommendation ITU-R SA.1023 provides a methodology for deriving sharing criteria based on interference criteria, the anticipated spatial deployment of interfering stations and the associated temporal characteristics of interfering signals;

d) that the typical deployment of interfering stations may change over a period of several years as a result of growth in the number of systems and revisions to frequency band allocations that are adopted by world radio conferences;

e) that the interference environment encountered by shipborne earth stations in the meteorological-satellite service is unlikely to be worse than that encountered by earth stations operating on land;

f) that the potential interference received by the Earth exploration-satellite service (EESS) and meteorological-satellite earth stations is the aggregate effect of several sources, including systems from other services allocated in these frequency bands, and systems not being allocated within the same band,

recommends

1 that the single entry interference levels presented in Table 1 should be used as sharing criteria for the protection of earth stations operating in the Earth exploration-satellite and meteorological-satellite services;

2 that the deployment of interferers specified in Annex 1 is the basis for Table 1 to be reviewed periodically in order to determine whether the typical interference environment and consequential sharing criteria should be revised;

3 that system performance degradation due to emissions from stations in services with lower allocation status than that of the EESS or the meteorological-satellite service should not exceed 1% of the applicable interference criteria.

TABLE 1

Sharing criteria for Earth exploration-satellite and meteorological-satellite earth stations using spacecraft in low-Earth orbit (see Notes 1, 2, 3 and 4)

a) Frequency ranges 137-138 MHz and 400.15-401.00 MHz

Frequency band (MHz)	Type of earth station	Interfering signal power (dBW) in the reference bandwidth to be exceeded no more than 20% of the time		Interfering signal power (dBW) in the reference bandwidth to be exceeded no more than p% of the time	
		Interfering signal path		Interfering signal path	
		Space-to-Earth	Terrestrial	Space-to-Earth	Terrestrial
137-138	Analogue receiver 2 dBic antenna gain Direct data readout	–156 dBW per 50 kHz(1)	–155 dBW per 50 kHz(1)	–146 dBW per 50 kHz(1) p = 0.0031	–146 dBW per 50 kHz(1) p = 0.0063
	Digital receiver 10 dBic antenna gain Direct data readout	–142 dBW per 150 kHz	–147 dBW per 150 kHz	–133 dBW per 150 kHz p = 0.0063	–134 dBW per 150 kHz p = 0.0063
	Digital receiver 2 dBic antenna gain Direct data readout	–147 dBW per 150 kHz(1)	–146 dBW per 150 kHz(1)	–137 dBW per 150 kHz(1) p = 0.0031	–137 dBW per 150 kHz(1) p = 0.0063
400.15-401.00	0 dBic antenna gain Direct data readout	–161 dBW per 177.5 kHz	–163 dBW per 177.5 kHz	–147 dBW per 177.5 kHz p = 0.0031	–147 dBW per 177.5 kHz p = 0.0063

b) Frequency range 1 698-1 710 MHz

Frequency band (MHz)	Type of earth station	Interfering signal power (dBW) in the reference bandwidth to be exceeded no more than 20% of the time		Interfering signal power (dBW) in the reference bandwidth to be exceeded no more than p% of the time	
		Interfering signal path		Interfering signal path	
		Space-to-Earth	Terrestrial	Space-to-Earth	Terrestrial
1 698-1 700	46.8 dBic antenna gain Recorded data playback	–131 dBW per 5 334 kHz	–131 dBW per 5 334 kHz	–122 dBW per 5 334 kHz p = 0.0050	–121 dBW per 5 334 kHz p = 0.0025
	29.8 dBic antenna gain Direct data readout	–150 dBW per 2 668 kHz	–150 dBW per 2 668 kHz	–138 dBW per 2 668 kHz p = 0.0050	–138 dBW per 2 668 kHz p = 0.0025
	22.5 dBic antenna gain Low-rate data	–147 dBW per 6 000 kHz	–147 dBW per 6 000 kHz	–134 dBW per 6 000 kHz p = 0.0050	–134 dBW per 6 000 kHz p = 0.0025

TABLE 1 (*continued*)

b) Frequency range 1 698-1 710 MHz

Frequency band (MHz)	Type of earth station	Interfering signal power (dBW) in the reference bandwidth to be exceeded no more than 20% of the time		Interfering signal power (dBW) in the reference bandwidth to be exceeded no more than *p*% of the time	
		Interfering signal path		Interfering signal path	
		Space-to-Earth	Terrestrial	Space-to-Earth	Terrestrial
1 700-1 710	46.8 dBic antenna gain Recorded data playback	135 dBW per 5 334 kHz	–129 dBW per 5 334 kHz	–122 dBW per 5 334 kHz $p = 0.0016$	–121 dBW per 5 334 kHz $p = 0.0094$
	29.8 dBic antenna gain Direct data readout	–157 dBW per 2 668 kHz	–151 dBW per 2 668 kHz	–139 dBW per 2 668 kHz $p = 0.0016$	–138 dBW per 2 668 kHz $p = 0.0094$
	22.5 dBic antenna gain Low-rate data	–154 dBW per 6 000 kHz	–148 dBW per 6 000 kHz	–134 dBW per 6 000 kHz $p = 0.0016$	–134 dBW per 6 000 kHz $p = 0.0094$

c) Frequency range 7 750-8 400 MHz

Frequency band (MHz)	Type of earth station	Interfering signal power (dBW) in the reference bandwidth to be exceeded no more than 20% of the time		Interfering signal power (dBW) in the reference bandwidth to be exceeded no more than *p*% of the time	
		Interfering signal path		Interfering signal path	
		Space-to-Earth	Terrestrial	Space-to-Earth	Terrestrial
7 750-7 850	55.2 dBic antenna gain Recorded data playback	–151 dBW per 10 MHz	–148 dBW per 10 MHz	–129 dBW per 10 MHz $p = 0.0047$	–129 dBW per 10 MHz $p = 0.0016$
	41.7 dBic antenna gain High-rate data 2-metre	–144 dBW per 10 MHz	–141 dBW per 10 MHz	–126 dBW per 10 MHz $p = 0.0047$	–126 dBW per 10 MHz $p = 0.0016$
8 025-8 400	54.8 dBic antenna gain Recorded data playback	–165 dBW per 10 MHz	–148 dBW per 10 MHz	–133 dBW per 10 MHz $p = 0.0025$	–133 dBW per 10 MHz $p = 0.0050$
	41.7 dBic antenna gain Direct data readout	–155 dBW per 10 MHz	–138 dBW per 10 MHz	–128 dBW per 10 MHz $p = 0.0025$	–127 dBW per 10 MHz $p = 0.0050$
	42.5 dBic antenna gain Direct data readout	–159 dBW per 10 MHz	–142 dBW per 10 MHz	–129 dBW per 10 MHz $p = 0.0013$	–129 dBW per 10 MHz $p = 0.0056$

TABLE 1 (*end*)

d) Frequency range 25.5-27.0 GHz

Frequency band (GHz)	Type of earth station	Interfering signal power (dBW) in the reference bandwidth to be exceeded no more than 20% of the time		Interfering signal power (dBW) in the reference bandwidth to be exceeded no more than *p*% of the time	
		Interfering signal path		Interfering signal path	
		Space-to-Earth	Terrestrial	Space-to-Earth	Terrestrial
25.5-27.0	55.2 dBic antenna gain Recorded data playback	–155 dBW per 10 MHz	–138 dBW per 10 MHz	–119 dBW per 10 MHz $p = 0.0025$	–119 dBW per 10 MHz $p = 0.0050$
	42.5 dBic antenna gain Direct data readout	–159 dBW per 10 MHz	–142 dBW per 10 MHz	–121 dBW per 10 MHz $p = 0.0025$	–121 dBW per 10 MHz $p = 0.0050$
	42.5 dBic antenna gain High-speed direct data readout	–156 dBW per 10 MHz	–139 dBW per 10 MHz	–122 dBW per 10 MHz $p = 0.0025$	–122 dBW per 10 MHz $p = 0.0050$
	58.2 dBic antenna gain Stored mission data	–146 dBW per 10 MHz	–129 dBW per 10 MHz	–107 dBW per 10 MHz $p = 0.0025$	–107 dBW per 10 MHz $p = 0.0050$

(1) In this case, the interfering signal powers (dBW) in the reference bandwidths are specified for reception at elevation angles ≥ 25°; in all other cases the minimum elevation angle is 5°.

NOTE 1 – The single entry interfering signal power thresholds in the above table are the permissible levels of interfering signal power that fall within the specified reference bandwidth. Accordingly, the total power in interfering signals that are narrower than the reference bandwidth should be considered in frequency sharing analyses. In cases where the interfering signal bandwidth exceeds the reference bandwidth or does not fully overlap the passband of a specific receiver under study, the available frequency dependent rejection should be applied in conjunction with the specified permissible interference levels.

NOTE 2 – In deriving the above sharing criteria from permissible total levels of interfering signal power, no allowance has been made for interference from spurious emissions.

NOTE 3 – Both the long-term (20% of the time) and short-term (< *p*% of the time) sharing criteria must be met in order for interference to be at or below permissible levels.

NOTE 4 – Sharing criteria specified for terrestrial signal paths are applicable to transmitting stations in terrestrial services and transmitting earth stations.

Annex 1

Basis for sharing criteria

1 Introduction

The objectives of sharing criteria are, on the one hand, to ensure that interference from all sources will not exceed the applicable interference criteria (i.e. permissible levels of total interference) and, on the other hand, to enable efficient sharing by allowing the maximum possible number of systems to share a band in the same area of operation (preferably on a co-channel basis). This Annex presents the basis for subdividing the applicable interference criteria (Recommendation ITU-R SA.1026) among the anticipated interferers. Table 2 presents the factors used in apportioning the total permissible interference for each relevant band between the categories of space-to-Earth and terrestrial interference paths as well as among the anticipated number of interferers in each of those categories. The following paragraphs discuss the interference environment in each band.

2 137-138 MHz band

The 137-138 MHz band is allocated to the space operation, meteorological-satellite and space research services on a primary basis; the mobile-satellite (space-to-Earth) on a primary basis in parts of the band and with a secondary basis in other paths of the band; and the fixed and mobile (except aeronautical mobile (R)) services on a secondary basis (except in administrations where that allocation is primary).

For most of the time at typical meteorological-satellite earth station sites, space stations such as those in the mobile-satellite service could produce higher levels of interference than terrestrial stations. The meteorological-satellite earth stations using antennas with 10 dBic gain will provide greater discrimination against terrestrial station emissions than will the earth stations using lower antenna gains (2 dBic). In the short-term, propagation enhancements on terrestrial interfering signal paths and the location variability of mobile stations may result in similar interference levels from space-to-Earth and terrestrial stations.

3 400.15-401.00 MHz band

The 400.15-401.00 MHz band is allocated on a secondary basis to the space operation, but on a primary basis to the meteorological-satellite, space research and mobile-satellite (space-to-Earth) services; the space research (space-to-space) service; and the meteorological aids service. In addition, the band is also allocated to the fixed and mobile services in some administrations on a primary basis.

For most of the time at typical meteorological-satellite earth station sites, space stations such as those in the mobile-satellite service could produce higher levels of interference than terrestrial stations. In the short-term, propagation enhancements on terrestrial interfering signal paths and the location variability of mobile and meteorological aids stations may result in similar interference levels from space-to-Earth and terrestrial stations.

4 1 698-1 710 MHz band

The 1 690-1 700 MHz band (of which the band 1 698-1 700 MHz is used for the non-geostationary meteorological satellites) is allocated to the meteorological-satellite (space-to-Earth) service on a primary basis and the Earth exploration-satellite (space-to-Earth) service on a secondary basis; the meteorological aids service on a primary basis; and to the fixed and mobile (except aeronautical mobile) services in Region 1 and several other areas on a secondary basis.

The 1 700-1 710 MHz band is allocated to the meteorological-satellite (space-to-Earth) service and the fixed and mobile (except aeronautical mobile) services on a primary basis and the Earth exploration-satellite (space-to-Earth) service on a secondary basis.

It is expected that an increasing number of space stations will be operated and produce about the same long-term interference levels as terrestrial systems.

5 7 750-7 850 MHz band

The 7 750-7 850 MHz band is allocated to the non-geostationary meteorological-satellite (space-to-Earth) service and the fixed and mobile (except aeronautical mobile) services on a primary basis. For long-term interference, it is expected that only a minor contribution will come from space-to-Earth links as the satellite passes rapidly through the antenna main beam. Consequently, a major contribution for short-term interference is then expected from space-to-Earth links.

6 8 025-8 400 MHz band

The 8 025-8 400 MHz band is allocated to the fixed-satellite (Earth-to-space) service on a primary basis, the Earth exploration-satellite (space-to-Earth) service on a primary basis, and the fixed and mobile services on a primary basis. In Region 2, aircraft transmissions are prohibited. In addition, the 8 175-8 215 MHz segment is allocated to the meteorological-satellite (Earth-to-space) service on a primary basis. Because the only sources of interference on space-to-Earth paths are from Earth exploration-satellite systems, no long-term interference is assumed to occur on space-to-Earth paths (i.e. for most of the time there is no interferer in view or high levels of earth station antenna discrimination are available). In the short-term, interference may occur among Earth exploration-satellite systems on space-to-Earth paths, although interference on terrestrial signal paths will predominate (especially for direct data readout earth stations, which have less antenna discrimination towards the horizon than recorded data acquisition stations). Regarding interference from FSS earth stations operating in the Earth-to-space direction, the sharing criteria specified for terrestrial signal paths should also be applicable to transmitting stations in terrestrial services and transmitting earth stations.

7 25.5-27.0 GHz band

The 25.5-27.0 GHz band is allocated to the Earth exploration-satellite and space research (space-to-Earth), fixed, mobile, and inter-satellite services. Potential sources of interference on Earth exploration-satellite space-to-Earth paths are other Earth exploration-satellite system satellites, inter-satellite service satellites and terrestrial fixed and mobile systems. No long-term interference is assumed to occur on the Earth exploration-satellite space-to-Earth path due to Earth exploration-satellite and inter-satellite service satellite emissions because of the constant movement of the satellites (i.e. for most of the time there is no interferer in view or high levels of earth station antenna discrimination are available). In the short term, interference may occur between Earth exploration-satellite and inter-satellite service satellite systems on space-to-Earth paths, although interference on terrestrial signal paths will predominate.

TABLE 2

Parameters used to derive sharing criteria from interference criteria

Frequency band (MHz)	Type of earth station	Long-term apportionment between categories of interferers		Short-term apportionment between categories of interferers		Equivalent number of long-term interferers		Equivalent number of short-term interferers	
		Interfering signal path		Interfering signal path		Interfering signal path		Interfering signal path	
		Space-to-Earth	Terrestrial	Space-to-Earth	Terrestrial	Space-to-Earth	Terrestrial	Space-to-Earth	Terrestrial
137-138	2 dBic antenna gain Direct data readout Analogue and digital receivers	60%	40%	50%	50%	2	1	2	1
	10 dBic Antenna gain (tracking)	75%	25%	50%	50%	1	1	1	1
400.15-401.00	0 dBic Antenna gain (non-tracking) Direct data readout	75%	25%	50%	50%	2	1	2	1
1 698-1 700	46.8 dBic Antenna gain Recorded data playback	50%	50%	80%	20%	1	1	2	1
	29.8 dBic Antenna gain Direct data readout	50%	50%	80%	20%	1	1	2	1
	22.5 dBic Antenna gain Low-rate data	50%	50%	80%	20%	1	1	2	1
1 700-1 710	46.8 dBic Antenna gain Recorded data playback	20%	80%	25%	75%	1	1	2	1
	29.8 dBic Antenna gain Direct data readout	20%	80%	25%	75%	2	2	2	1
	22.5 dBic Antenna gain Low-rate data	20%	80%	25%	75%	2	2	2	1

TABLE 2 (*end*)

Frequency band (MHz)	Type of earth station	Long-term apportionment between categories of interferers		Short-term apportionment between categories of interferers		Equivalent number of long-term interferers		Equivalent number of short-term interferers	
		Interfering signal path		Interfering signal path		Interfering signal path		Interfering signal path	
		Space-to-Earth	Terrestrial	Space-to-Earth	Terrestrial	Space-to-Earth	Terrestrial	Space-to-Earth	Terrestrial
7 750-7 850	55.2 dBic Antenna gain Recorded data playback	20%	80%	75%	25%	1	2	2	2
	41.7 dBic Antenna gain High-rate data 2-metre antenna	20%	80%	75%	25%	1	2	2	2
8 025-8 400	54.8 dBic Antenna gain Recorded data playback	1%	99%	20%	80%	1	2	1	2
	42.5 dBic Antenna gain Direct data readout	1%	99%	10%	90%	1	2	1	2
	41.7 dBic Antenna gain Direct data readout	1%	99%	20%	80%	1	2	1	2
25 500-27 000	55.2 dBic Antenna gain Recorded data playback Direct data readout	1%	99%	20%	80%	1	2	1	2
	42.5 dBic Antenna gain Direct data readout	1%	99%	20%	80%	1	2	1	2
	42.5 dBic Antenna gain High-speed direct data readout	1%	99%	20%	80%	1	2	1	2
	58.2 dBic Antenna gain Stored mission data	1%	99%	20%	80%	1	2	1	2