



Recommendation ITU-R SA.1026-5
(07/2017)

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

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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.1026-5

Aggregate interference criteria for space-to-Earth data transmission systems operating 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)

(1994-1995-1997-1999-2009-2017)

Scope

The purpose of this Recommendation is to provide aggregate interference criteria for space-to-Earth transmissions from low-Earth orbiting satellites, applying to both the Earth exploration-satellite and the meteorological-satellite services.

Keywords

EESS, METSAT, non-GSO satellites, aggregate interference criteria

Related Recommendations and Reports

Recommendations ITU-R SA.514, ITU-R SA.1020, ITU-R SA.1021, ITU-R SA.1022, ITU-R SA.1023, ITU-R SA.1027, ITU-R SA.1159

The ITU Radiocommunication Assembly,

considering

- a) that the hypothetical reference system specified in Recommendation ITU-R SA.1020 defines space-to-Earth links for a number of functions, including the direct readout of data and playback of recorded data;
- b) that interference criteria are needed to ensure that systems can be designed to achieve adequate performance in the presence of interference and to assist in developing criteria for sharing bands among systems, including those operating in other services;
- c) that spacecraft operating in the Earth exploration-satellite and meteorological-satellite services may utilize low-Earth orbits;
- d) that performance objectives for the relevant space-to-Earth data transmission systems operating in the Earth exploration-satellite and meteorological-satellite services are specified in Recommendation ITU-R SA.1159 for several frequency bands;
- e) that, although specific data transmission systems may have performance objectives that differ from those recommended for the Earth exploration-satellite and meteorological-satellite services, all systems operating in those services should accommodate interference criteria greater than or equal to the permissible levels of interference that are recommended for the services;
- f) that interference criteria for data transmission systems in the Earth exploration-satellite and meteorological-satellite services are derived by using the methods in Recommendation ITU-R SA.1022;

g) that Annex 1 presents the parameters of representative systems that provide the basis for interference criteria for space-to-Earth transmissions in the Earth exploration-satellite and meteorological-satellite services in some frequency bands,

recommends

1 that the interference criteria for the frequency bands specified in Table 1 should be used as the permissible aggregate levels of interfering signal power at the antenna output of earth stations operating in the Earth exploration-satellite and meteorological-satellite services with satellites in low-Earth orbit;

TABLE 1

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

Frequency band	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 0.0125% of the time. (This value is based on the 99.9% performance requirement in Recommendation ITU-R SA.1159)
137-138 MHz	−142 dBW per 150 kHz ⁽¹⁾	−136 dBW per 150 kHz ⁽¹⁾
400.15-401.00 MHz	−157 dBW per 177.5 kHz	−147 dBW per 177.5 kHz
1 698-1 710 MHz	−146 dBW per 2 668 kHz	−138 dBW per 2 668 kHz
7 750-7 900 MHz	−144 dBW per 10 MHz	−127 dBW per 10 MHz
8 025-8 400 MHz	−147 dBW per 10 MHz	−133 dBW per 10 MHz
25.5-27.0 GHz	−140 dBW per 10 MHz	−116 dBW per 10 MHz

⁽¹⁾ The interfering signal powers (dBW) in the reference bandwidths are specified for reception at elevation angles $\geq 25^\circ$; in all other cases the minimum elevation angle is 5° .

Notes to Table 1

NOTE 1 – The aggregate interfering signal power level that may be exceeded for no more than $x\%$ of the time, where x is less than 20% but greater than the specified short-term time percentage (0.0125% of the time), may be determined by interpolation between the specified values using a logarithmic scale (base 10) for percentage of time and a linear scale for interfering signal power density (dB).

NOTE 2 – The interference criteria are specified with respect to the percentage of time of reception by the earth station. Thus, receiver performance statistics associated with reception from one particular satellite (i.e. cumulative distribution of bit error rate (BER)) are the same as the statistics for reception from several similar satellites. The total time of reception includes time periods associated with initial signal acquisition (i.e. before and during local ascension of the satellite), receiver synchronization of the data, and synchronized reception of data. Consequently, because the time required for initial signal acquisition and synchronization may constitute up to several tens of seconds out of total satellite visibility periods averaging on the order of nine minutes, the analyses of short-term performance that are presented in Annex 1 (i.e. performance exceeded for all but a small percentage of time p , $p \leq 1\%$) assume that the satellite is located at the minimum elevation angle associated with the applicable performance objective. This yields the BER performance exceeded for all but $p\%$ of the time because E_b/N_0 and BER are monotonically related to elevation angle.

Notes to Table 1 (end):

NOTE 3 – The elevation angle exceeded for all but 20% of the time during reception is approximated well by the angle exceeded for all but 20% of the time that the satellite is visible above the minimum elevation angle specified in the performance objective. This approximation is made in the performance analyses presented in Annex 1 because the underlying cumulative time error cannot exceed 1% (i.e. $p\%$ of the time) and the associated total error in satellite antenna gain, free space loss, excess path loss, and earth station parameter values are negligible. The resulting elevation angle that is exceeded for all but 20% of the time of reception yields the BER performance exceeded for all but 20% of the time because E_b/N_0 and BER are monotonically related to elevation angle.

NOTE 4 – For frequency bands other than those of Table 1, the interference criterion of Recommendation ITU-R SA.514 is applicable.

Annex 1

Basis for determination of interference criteria

1 Introduction

This Annex presents, on a band-by-band basis, the parameters used with the methodology of Recommendation ITU-R SA.1022 in the derivation of interference criteria for the Earth exploration-satellite and meteorological-satellite services using the performance objectives specified in Recommendation ITU-R SA.1159. The performance analyses for a number of reference systems are summarized in Table 2. In all cases, the representative systems utilize satellites in highly-inclined circular orbits.

It should be noted that in Table 2 and §§ 2 to 7 below, the terms M_{min} , M_{min} (long-term) and M_{min} (short-term) are to be understood in the sense of the methodology described in Recommendation ITU-R SA.1022, i.e. “the smallest interference-free margin for which the victim system must be fully protected”. It should not be taken as representative for all EESS and METSAT systems, in particular those in Table 2, among of which certain systems present lower power margins.

TABLE 2
Performance analyses used as a basis for interference criteria

Frequency band (MHz)	137-138					
Type of earth station	Low gain earth station (APT) (system A)		Tracking earth station (LRPT) (system B)		Low gain earth station (LRPT) (system C)	
Percentage of time for link margin not met, p	0.05	20	0.05	20	0.05	20
Elevation angle (exceeded for p)	25°	30°	5°	13°	25°	30°
Satellite antenna input power (dBW)	4.9		6.8		6.8	
Satellite antenna gain (dBic)	0.7	1.1	-1.2	-0.5	0.7	1.1
Satellite e.i.r.p. (dBW)	5.6	6.0	5.6	6.3	7.5	7.9
Free space loss (dB)	139.4	138.5	144.3	142.2	139.4	138.5
Excess path loss (dB)	0.2		0.1	0.1	0.1	
Earth station antenna gain (dBic)	2.0		10.0	10.0	2.0	
Antenna mispointing loss (dB)	0.0		0.0	0.0	0.0	
Polarization mismatch loss (dB)	1.5		1.5	1.5	1.5	
Modulator and demodulator losses (dB)	0.0		2.0	2.0	2.0	
Receiver reference bandwidth (kHz)	50		150		150	
Data rate (dB-Hz)	45.7 occupied bandwidth		48.6		48.6	
Received energy per bit, E_b (dB(W/Hz))	-179.2 (C_0)	-177.9 (C_0)	-180.9	-178.1	-182.1	-180.8
Receiver system noise temperature (K)	2 520		1 750		1 750	
Thermal noise power density (dB(W/Hz))	-194.6		-196.2		-196.2	
Non-thermal receiver noise power density (dB(W/Hz))	-		-		-	
Total internal noise power density, N_0 (dB(W/Hz))	-194.6		-196.2		-196.2	
E_b/N_0 (dB)	15.4(C_0/N_0)	16.7(C_0/N_0)	15.3	18.1	14.1	15.4
Link bit-error ratio	-		10^{-10}		$< 10^{-10}$	
Overall received bit-error ratio	-		$< 10^{-10}$		$< 10^{-10}$	
Threshold E_b/N_0 (or C/N) (dB)	12.0		6.5		6.5	
Power margin (dB)	3.4	4.7	8.8	11.6	7.6	8.9
q factor (lt: long-term, st: short-term)	0.5 (lt)	1 (st)	0.6 (lt)	1 (st)	0.6 (lt)	1 (st)
M_{min} (dB)	0.8		1.2		1.2	
Percentage of time for interference criteria	20	0.0125	20	0.0125	20	0.0125
Interference criteria dBW in reference bandwidth	-151	-145	-141	-133	-142	-136