RECOMMENDATION ITU-R SA.1807

System characteristics and interference criteria for meteorological satellite systems operating around 18 GHz

(2007)

Scope

This ITU-R Recommendation presents interference criteria for meteorological satellite (MetSat) systems operating around 18 GHz and the system parameters used for its derivation. These criteria provide the basis for determining the sharing possibilities with the other allocated services.

The ITU Radiocommunication Assembly,

considering

a)   that interference criteria are needed to ensure that meteorological satellite systems can be designed to achieve adequate performance in the presence of interference;

b)   that frequency bands around 18 GHz allocated to the meteorological satellite (MetSat) service are shared with the fixed service, the mobile service and the fixed-satellite service (FSS) on a co-primary basis;

c)   that interference criteria assist in the development of criteria for sharing bands among systems, including those that will operate in other services;

d)   that interfering signals from nearby satellites on the GSO are likely to be attenuated by rain to the same extent as the wanted signal;

e)   that interfering signals from terrestrial sources will in general have quite different attenuation to the wanted signal,

recommends

1   that the interference criteria contained in Table 1 should be used for triggering coordination with future terrestrial and space service systems;

2   that the system characteristics and methods specified in Annex 1 should be used as the baseline for deriving interference parameters for the MetSat service operating in frequency bands near 18 GHz;

3   that a 6% increase in equivalent link noise temperature should be used for triggering coordination between transmitting space stations and receiving earth stations operating in the MetSat service;

4   that antenna side-lobe specifications for meteorological earth stations should be based on Recommendation ITU-R S.580.

TABLE 1

Interference criteria for stations in the MetSat service using spacecraft in geostationary orbit

Function and type of earth station	Interfering signal power in the reference bandwidth to be exceeded for no more than *20%* of the time (dB(W/10 MHz))		Interfering signal power in the reference bandwidth to be exceeded for no more than p% of the time (dB(W/10 MHz))	
	Space	Terrestrial	Space	Terrestrial
Direct data readout 61 dBi antenna System A	$-129.1^{(1)}$	$-140.7^{(2)}$	$-114.4^{(3)}$ $p = 0.025$	$-114.4^{(4)}$ $p = 0.025$
Direct data readout 66 dBi antenna System B	$-132.0^{(1)}$	$-145.7^{(2)}$	$-117.3^{(3)}$ $p = 0.025$	$-117.3^{(4)}$ $p = 0.025$

System A is optimized for 2° orbital spacing in an interference limited operating environment and System B is optimized for operation in a noise limited environment.

[1]   Level per satellite based on aggregate interference from eight neighbouring satellites equally spaced at 2° on the GSO and 50% interference attribution to space services.

[2]   Level for a single terrestrial system based on 50% interference attribution to terrestrial sources.

[3]   Based on occasional short-term interference from two non-GSO satellites and 50% interference attribution to space services.

[4]   Based on occasional short-term interference from two sources and 50% interference attribution to terrestrial services.

Annex 1

Technical characteristics of MetSat systems operating around 18 GHz

This Annex presents the parameters used to determine the interference criteria for meteorological direct readout systems. Typical system designs for the next-generation meteorological satellites focus on a GSO satellite transmitting data into a relatively large earth station at carrier frequencies around 18.2 GHz. Relevant system characteristics are shown in Table 1. Antenna side-lobe patterns of meteorological stations should be in accordance with Recommendation ITU-R S.580 for FSS antennas based on a $29 - 25 \log \theta$ roll-off in order to facilitate the sharing situation with the FSS.

A system availability of 99.9% is commonly required and has been assumed as the baseline although a trend towards 99.99% is noticeable. Bit-error rates around 10^{-7} are standard practice for systems using channel coding. The required *S*/*N* is based on 8-PSK modulation with $R = 1/2$ convolutional channel coding and technical losses of 2 dB.

Two different types of systems have been considered. System A is optimized for 2° orbital spacing in an interference limited operating environment and System B is optimized for operation in a noise limited environment.

For determining the interference criteria, data from the link budget, in particular the margins and the S/Ns have been used in connection with the algorithm of Recommendation ITU-R SA.1022 to determine the permissible interference power densities for long- and short-term conditions.

TABLE 1

Link budget examples for meteorological satellite systems operating around 18 GHz

	System A	System B	Units
Carrier frequency	18.2	18.2	GHz
Maximum bandwidth	300	300	MHz
Minimum elevation angle	5	5	degrees
Satellite RF power	16.8	10.0	dBW
Satellite antenna gain	48.1	46.5	dBi
Isolator, filter, equalizer, cable and connector losses	2.0	2.0	dB
Satellite e.i.r.p.	62.9	54.5	dBW
Distance satellite – earth station	41 343	41 343	km
Free space propagation loss	210.0	210.0	dB
Polarization, pointing and atmospheric losses	0.9	0.9	dB
Long-term downlink loss	210.9	210.9	dB
Rain margin for 99.9% availability	15.0	15.0	dB
Short-term downlink loss	225.9	225.9	dB
Earth station antenna diameter	8.0	15.0	m
Earth station antenna gain	60.7	66.1	dBi
Short-term signal power level at receiver input	–102.3	–105.2	dBW
Receiver system temperature	300	300	K
pfd on surface of the Earth	–122.2	–130.5	dB(W/(m$^2 \cdot$ MHz))
Receiver noise power density	–203.8	–203.8	dB(W/Hz)
Signal-to-noise density ratio (C/N_0) – long-term	116.5	113.6	dB/Hz
Signal-to-noise density ratio (C/N_0) – short-term	101.5	98.6	dB/Hz
Required C/N_0 for 8-PSK, $R = 1/2$ coded, BER $= 10E^{-7}$	97.0	97.0	dB/Hz
System margin – long-term	19.5	16.6	dB
System margin – short-term	4.49	1.58	dB

As the band is shared with several other services, an appropriate apportionment of the interference levels is required. Regarding the apportionment of long-term interference between space and terrestrial systems, it can be expected that approximately equal contributions will arise from space and terrestrial services around 18 GHz. It is therefore suggested to assume 50% attribution for each of these sources.

For long-term interference, a distinction should be made between terrestrial and space services with satellites on the GSO. Wanted and unwanted signals from nearby satellites on the GSO received by an earth station will be affected by rain attenuation in basically the same way. The unwanted signal will suffer from the same attenuation as the wanted signal as rain cells above an earth station are generally much larger than the area of intersection with the cone determined by the angular separation. It is therefore sufficient to specify only a *S/I*. In the specific case of interference from the FSS to the MetSat service, it was assumed that a *S/I* of 20 dB would be adequate. Coordination in this frequency band is usually carried out for satellites within ±8º on the GSO. With an envisaged angular separation of 2º, interference from eight satellites needs to be taken into account. The interference reduction for a single FSS satellite as compared to the aggregate interference from eight satellites is then 4 dB based on the typical antenna side-lobe roll-off. Table 2 contains the parameters leading to the recommended interference criteria.

TABLE 2

Long-term interference power density criteria applicable to the FSS

	System A	**System B**	**Units**
Received long-term MetSat signal power level	−87.3	−90.2	dBW
Received long-term signal power level density	−102.1	−105.0	dB(W/10 MHz)
Required signal-to-interference ratio	20.0	20.0	dB
Long-term interference attribution to the FSS (%)	50	50	
Acceptable aggregate FSS interference power density	−125.1	−128.0	dB(W/10 MHz)
Reduction factor assuming eight satellites with 2º separation	4.0	4.0	dB
Permissible long-term interference power density criteria for a single FSS system	−129.1	−132.0	dB(W/10 MHz)

Signal paths from terrestrial interference sources will normally experience an unrelated attenuation as compared to the wanted signal. Higher margins must therefore be included to cover cases where maximum attenuation occurs for the wanted signal whereas the interfering signal is basically not attenuated. For determining the long-term permissible interference from terrestrial services, it was assumed that one third of the short-term margin would be available ($q = 1/3$). The following equation contained in Recommendation ITU-R SA.1022 has been used.

$$I_0 = N_0\left(M^q - 1\right)$$

where:

I_0:   aggregate long-term interference density

N_0:   noise density of meteorological earth station

M: long-term margin

q: margin reduction factor.

Table 3 contains the parameters leading to the recommended interference criteria.

TABLE 3

Long-term interference power density criteria applicable to the fixed service

	System A	System B	Units
MetSat noise power density	−133.83	−133.83	dB(W/10 MHz)
MetSat short-term system margin	4.49	1.58	dB
Fraction of acceptable short-term margin reduction (factor q in Recommendation ITU-R SA.1022)	0.33	0.33	
Remaining desirable short-term margin	3.0	1.1	dB
Permissible long-term interference power density	−137.7	−142.7	dB(W/10 MHz)
Attribution of total long-term interference to the fixed service (%)	50	50	
Assumed number of fixed service systems causing the interference	1	1	
Permissible long-term interference criteria for a single fixed service system	−140.7	−145.7	dB(W/10 MHz)

Regarding the number of short-term interferers, two non-GSO FSS satellites have been assumed for space services and two fixed service links coupling on rare occasions via the troposphere or ducting for terrestrial systems.

For the short-term permissible interference excess, the entire long-term margin is available ($q = 1$), resulting basically in a loss of the connection. A short-term interference excess probability of 0.1% was considered adequate in line with a system availability of 99.9%. This value applies to the aggregate interference from terrestrial and space services. Table 4 contains the parameters leading to the recommended interference criteria.

TABLE 4

**Short-term interference power density criteria applicable
to the fixed service and the FSS**

	System A	System B	Units
MetSat noise power density	−133.8	−133.8	dB(W/10 MHz)
MetSat long-term system margin	19.5	16.6	dB
Fraction of acceptable long-term margin reduction (factor q in Recommendation ITU-R SA.1022)	1.0	1.0	
Remaining short-term margin in dB	0.0	0.0	dB
Permissible short-term interference power density criteria	−114.4	−117.3	dB(W/10 MHz)
Percentage of time interference level may be exceeded (%)	0.10	0.10	
Assumed number of fixed service systems causing short-term interference	2	2	
Assumed number of FSS systems causing short-term interference	2	2	
Permissible percentage of time for a single fixed service or FSS system (%)	0.025	0.025	