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| **Recommendation ITU-R SA.1160-3**  **(07/2017)** |
| **Aggregate interference criteria for data transmission systems in the Earth exploration-satellite and meteorological-satellite services using satellites in the geostationary orbit** |
| **SA Series**  **Space applications and meteorology** |

Foreword

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| **SM** | Spectrum management |
| **SNG** | Satellite news gathering |
| **TF** | Time signals and frequency standards emissions |
| **V** | Vocabulary and related subjects |

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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.1160-3

Aggregate interference criteria for data transmission systems in the Earth exploration-satellite and meteorological-satellite services using satellites in the geostationary orbit

(Question ITU-R 141/7)

(1995-1997-1999-2017)

Scope

The purpose of this Recommendation is to provide aggregate interference criteria for data transmission links for GSO satellites in the Earth exploration-satellite and meteorological‑satellite services.

Keywords

EESS, METSAT, GSO satellites, data transmission, interference criteria

Related Recommendations and Reports

Recommendations ITU-R SA.1022, ITU-R SA.1159 and ITU-R SA.1161

The ITU Radiocommunication Assembly,

considering

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

*b)* that interference criteria may be determined using the methodology described in Recommendation ITU‑R SA.1022 and the performance objectives listed in Recommendation ITU‑R SA.1159;

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

*d)* that systems in the Earth exploration-satellite service (EESS) and meteorological-satellite (MetSat) service must specify interference thresholds at levels greater than or equal to the permissible levels;

*e)* that the Annex presents the parameters of representative systems that provide the basis for determination of interference criteria for pertinent transmissions in the EESS and MetSat service,

recommends

that the interference criteria levels specified in Table 1 should be used as the permissible aggregate levels of interfering signal power at the antenna output of stations operating in the EESS and MetSat service.

TABLE 1

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

|  |  |  |
| --- | --- | --- |
| Frequency band (MHz) | Interfering signal power (dBW) in the reference bandwidth to be exceeded for no more than 20% of the time | Interfering signal power (dBW) in the reference bandwidth to be exceeded for no more than *p*% of the time |
| 1 670-1 710  space-to-Earth | −158.0 dBW per 1 MHz | −152.8 dBW per 1 MHz  *p*  0.025 |
| 2 025-2 110  Earth-to-space | −139.9 dBW per 1 MHz | −136.6 dBW per 1 MHz  *p*  0.025 |
| 25 500-27 000  space-to-Earth | −144.6 dBW per 10 MHz | −133.0 dBW per 10 MHz  *p*  0.25 |
| NOTE 1 – The interfering signal powers (dBW) in the reference bandwidths are specified for reception at elevation angles ≥ 3°.  NOTE 2 – The total 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 (*p*% 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 3 – The interference criteria can be expressed as permissible power flux‑densities into the main beam of the receive antenna by subtracting 10 log(*G* λ2/4π) from the value given in Table 1, where *G* is the receive antenna gain and λ is the wavelength.  NOTE 4 – Although the interference criteria are based on the systems described in the Annex, the interference criteria apply to all systems that operate in the subject frequency bands and which provide the specified service functions. | | |

Annex  
  
Basis for determination of interference criteria

This Annex presents the parameters used as inputs to the methodology of Recommendation ITU‑R SA.1022 to determine the interference criteria for raw instrument data downlink transmissions to main reception earth stations belonging to satellite operator and data dissemination to user stations.

# 1 Raw instrument data downlink transmissions to main reception earth stations

Table 2 develops these criteria for raw instrument data downlink transmissions to main reception earth stations, in which all of the interference enters the receiving earth station directly, and none is received at these stations via the satellite that originates the data.

The interference criteria can be expressed as permissible power flux-densities into the main beam of the receive antenna by subtracting 10 log(*G*λ2/4π) from the values given in Table 2, where *G* is the receive antenna gain and λ is the wavelength.

TABLE 2

Performance of raw instrument data downlink transmissions to main reception   
earth stations used as a basis for interference criteria of stations operating with   
satellites in geostationary orbit

a) Frequency band 1 670-1 710 MHz

|  |  |  |  |
| --- | --- | --- | --- |
| Link parameter | | Value | Notes |
| Down-link e.i.r.p. | | 16.1 dBW |  |
| Down-link loss | | 190.1 dB | Free-space, polarization, and antenna pointing |
| Down-lnk *G*/*T* | | 24.4 dB(K–1) |  |
| Down-link *C*/N0 | | 79.0 dB.Hz |  |
| Data rate | | 2.6 Mbit/s |  |
| Required *C*/*N*0 | | 78.1 dB.Hz | BER  1  10−6 2.2 dB implementation loss 1 dB modulation loss |
| Margin | | 0.9 dB | Long-term and short-term |
| Receive antenna gain | | 45.1 dBi |  |
| Receiver noise density | | –207.9 dB(W/Hz) |  |
| Interference criteria | Long-term | –153.9 dB(W/2.6 MHz) | *q*  1/3 and *Mmin*  1.2 dB |
| Short-term | –148.7 dB(W/2.6 MHz) | *q*  1 and *Mmin*  1.2 dB |

b) Frequency band 25.5-27.0 GHz

|  |  |  |  |
| --- | --- | --- | --- |
| Link parameter | | Value | Notes |
| Down-link e.i.r.p. | | 55.5 dBW |  |
| Down-link loss | Long-term | 227.9 dB | Free-space, rain and atmospheric, polarization, and antenna pointing |
| Short-term | 231.3 dB | 7.1 dB excess loss |
| Down-link *G*/*T* | | 37.6 dB(K–1) |  |
| Down-link *C*/*N*0 | Long-term | 93.8 dB.Hz |  |
| Short-term | 90.4 dB.Hz |  |
| Data rate | | 164 Mbit/s |  |
| Required *C*/*N*0 | | 88.7 dB.Hz | BER  1  10−9 1.5 dB implementation loss 1.75 dB modulation loss |
| Margin | Long-term | 5.1 dB |  |
| Short-term | 1.7 dB |  |
| Receive antenna gain | | 60.6 dBi | Including pointing losses |
| Receiver noise density | | –205.6 dB(W/Hz) |  |
| Interference criteria | Long-term | –144.6 dB(W/10 MHz) | *q*  0.1 and *Mmin*  4.5 dB |
| Short-term | –133.0 dB(W/10 MHz) | *q*  1 and *Mmin*  4.5 dB |

# 2 Data dissemination to user stations

Dissemination of high-resolution processed data is affected by interference received at the station via the satellite as well as by interference transmitted directly into the station in the 1 670-1 710 MHz band. The high-resolution processed data are up-linked to the satellite in the 2 025-2 110 MHz band, and relayed, along with interfering signals entering the satellite in the same band, to the Earth station receivers via fixed-gain satellite transponders.

The up-link and down-link carrier-to-noise plus interference density ratios are respectively:



and



where:

*I*01 and *I*02 : interference densities transmitted into the satellite and station receivers

*T*1 and *T*2 : system noise temperatures of the satellite and station receivers

*k*: Boltzmann’s constant.

The composite carrier-to-noise plus interference density ratio is:



From Recommendation ITU-R SA.1022 this can also be written:



where:

*M*: interference-free margin

*q*: action of the interference-free margin that the interference is allowed to consume

*C*/*N*0 : composite carrier-to-noise density ratio given by:



From the foregoing equations:



Assume that the up-link and down-link interference are allocated so that a fraction *p* of the interference received at the earth station is received via the satellite, and that a fraction 1*– p* is transmitted directly into the station. It is desirable for *p* to be near 1/2 in order to provide a reasonable balance in the interference allocated to the up-link and to the down-link. For a fixed-gain transponder it can be shown that:



so that:



Accordingly, the permissible up-link interference density becomes:

 for *M*  *Mmín*

where, according to Recommendation ITU-R SA.1022, *Mmin* is the smallest interference-free margin for which only a fraction *q* of the margin is consumed by the interference.Correspondingly, the permissible down-link interference density is:

 for *M*  *Mmin*

Table 3 summarizes the calculation of *I*01and *I*02 for high-resolution, assuming that *p*  1/2, *q*  1/3, and *Mmin*  1.2 dB for long-term interference, and that *p*  1/2, *q*  1, and *Mmin*  1.2 dB for short-term interference.

The interference criteria can be expressed as permissible power flux-densities into the main beam of the receive antenna by subtracting 10 log(*G* λ2/4π) from the values given in Table 3, where *G* is the receive antenna gain and λ is the wavelength.

TABLE 3

Performance analysis used as a basis for interference criteria  
of high-resolution data dissemination to user stations using geostationary satellites

| Link parameter | Value | Notes |
| --- | --- | --- |
| Up-link e.i.r.p. | 72.1 dBW |  |
| Up-link loss | 191.7 dB | Free-space, polarization, and antenna pointing |
| Up-link *G*/*T* | −17.5 dB(K−1) | Post-launch measurement |
| Up-link *C*/N0 | 91.5 dB/Hz |  |
| Down-link e.i.r.p. | 23.8 dBW |  |
| Down-link loss | 190.1 dB | Free-space, polarization, and antenna pointing |
| Down-link *G*/*T* | 15.2 dB(K−1) |  |
| Down-link *C*/*N*0 | 77.5 dB.Hz |  |
| Composite *C*/*N*0 | 77.3 dB.Hz |  |
| Data rate | 2.11 Mbit/s |  |
| Required *C*/*N*0 | 75.9 dB.Hz | BER  1  10−6  1.9 dB implementation loss |
| Margin | 1.4 dB |  |

TABLE 3 (*end*)

| Link parameter | | Value | Notes |
| --- | --- | --- | --- |
| Up-link receive antenna gain | | 9.5 dBi |  |
| Up-link noise density | | −201.6 dB(W/Hz) | *T*  500 K |
| Up-link interference criterion (2 025-2 110 MHz) | Long-term | −136.7 dB(W/2.11 MHz) | *q*  1/3 |
| Short-term | −133.4 dB(W/2.11 MHz) | *q*  1 |
| Down-link receive antenna gain | | 39.5 dBi |  |
| Down-link noise density | | −204.3 dB(W/Hz) | *T*  269 K |
| Down-link interference criterion (1 670-1 710 MHz) | Long-term | −153.4 dB(W/2.11 MHz) | *q*  1/3 |
| Short-term | −148.1 dB(W/2.11 MHz) | *q*  1 |

# 3 Conclusions

## 3.1 Frequency band 1 670-1 710 MHz

The above analyses provide two different sets of interference criteria, for raw instrument data downlink transmissions to main reception Earth stations and data dissemination to user stations respectively.

It is assumed that raw instrument data downlink transmissions to main reception Earth stations are the most representative systems in the band. For simplification, it is further proposed to normalise the criteria in a 1 MHz bandwidth, leading to the following values:

– long-term: −158.0 dBW/MHz

– short-term: −152.8 dBW/MHz.

## 3.2 Frequency band 2 025-2 110 MHz

The above analysis provides a single sets of interference criteria for data dissemination systems. For simplification, it is further proposed to normalise the criteria in a 1 MHz bandwidth, leading to the following values:

– long-term: −139.9 dBW/MHz

– short-term: −136.6 dBW/MHz

## 3.3 Frequency band 25.5-27 GHz

The above analysis provides a single sets of interference criteria for raw instrument data downlink transmissions to main reception, representing the new generation of systems using the band 25.5‑27 GHz and leading to the following values:

– long-term: −144.6 dBW/10 MHz

– short-term: −133.0 dBW/10 MHz