

RECOMMENDATION ITU-R M.1142-1*

**SHARING IN THE 1-3 GHZ FREQUENCY RANGE BETWEEN GEOSTATIONARY
SPACE STATIONS OPERATING IN THE MOBILE-SATELLITE SERVICE
AND STATIONS IN THE FIXED SERVICE**

(Questions ITU-R 201/8 and ITU-R 118/9)

(1995-1997)

Summary

Levels of power flux-density (pfd) are presented as thresholds for coordination of frequency assignments for geostationary (GSO) space station transmitters in the mobile-satellite service (MSS) and receiving stations in the fixed service in frequency bands shared between these services in the 1-3 GHz frequency range. The Annexes address fixed system considerations that may facilitate coordination and summarize studies of frequency sharing between transmitting fixed stations and GSO space station receivers in the MSS.

The ITU Radiocommunication Assembly,

considering

- a) that Resolutions 46 (Rev.WRC-95) of the World Radiocommunication Conference (Geneva, 1995), 113 (WARC-92) of the World Administrative Radio Conference for Dealing with Frequency Allocations in Certain Parts of the Spectrum (Malaga-Torremolinos, 1992), 703 (WARC-92) and Recommendation 717 (Rev.WRC-95) invited the ITU-R to study criteria for sharing and coordination between systems in the mobile-satellite and fixed services;
- b) that Recommendation 717 (Rev.WRC-95) invited the ITU-R to continue its studies of criteria for sharing and coordination between systems in the mobile-satellite and fixed services;
- c) that WARC-92 adopted new allocations in the 1-3 GHz range for the mobile-satellite service (MSS) in order to help meet the rapidly growing spectrum requirements of that service;
- d) that administrations have submitted advance publication data (Appendix S4 to the Radio Regulations (RR)) for mobile-satellite networks which, as a set, would operate throughout the frequency bands in the 1-3 GHz range that are shared with the fixed service (FS);
- e) that for several decades, many administrations have been operating systems in the FS in certain bands shared with the MSS, and will continue to do so,

considering further

for the MSS space-to-Earth direction:

- f) that the bands 2 170-2 200 MHz, and 2 483.5-2 500 MHz are allocated to the MSS (space-to-Earth) and FS on a co-primary basis in all three Regions;
- g) that the bands 1 492-1 525 MHz, 1 525-1 530 MHz and 2 160-2 170 MHz are allocated to the MSS (space-to-Earth) and FS in some Regions and some administrations, on a co-primary basis;
- h) that the band 2 500-2 535 MHz may be used by the MSS (space-to-Earth) in all three Regions subject to agreement obtained under the procedure set forth in RR No. S9.21, the band 2 500-2 520 MHz is allocated to that service on a primary basis as of 1 January 2005, and these and adjoining frequencies are allocated to the FS on a primary basis;
- j) that in the band 2 170-2 200 MHz, the allocation for the MSS shall not be implemented before 1 January 2000 (RR No. S5.389A);
- k) that in the band 2 160-2 170 MHz, the allocation for the MSS shall not be implemented before 1 January 2005 (RR No. S5.389C);

* The revision of this Recommendation was jointly prepared by Radiocommunication Study Groups 8 and 9 and any future revision will also be undertaken jointly.

- l) that in order to fulfil operating requirements, most types of mobile-satellite systems designed for operation in the 1-3 GHz range may have to generate power flux density (pfd) levels in excess of the levels specified in RR No. S21.16 (3 400-4 200 MHz band);
- m) that broadcasters in many countries operate ancillary services which have both fixed and mobile characteristics in the bands shared with the MSS;
- n) that some systems described in *considering* e) and m) above may have by necessity a low permissible level of interference owing to the nature of their operation or design, based upon their performance and availability requirements,

considering also

for the MSS Earth-to-space direction:

- o) that Recommendation ITU-R F.1246 establishes the reference bandwidth of systems in the FS, in the 1-3 GHz frequency range, to be used in specifying the coordination threshold levels;
- p) that the band 1 980-2 010 MHz is allocated to the mobile-satellite (Earth-to-space) service and FS on a co-primary basis, and that this allocation for the MSS shall not be implemented before 1 January 2000 except for the band 1 980-1 990 MHz in Region 2, the use of which shall not commence before 1 January 2005 (RR No. S5.389A);
- q) that in the bands 1 980-1 990 MHz and 2 010-2 025 MHz in Region 2, the allocation for the MSS (Earth-to-space) shall not be implemented until 1 January 2005 (RR Nos. S5.389A and S5.389C);
- r) that parts of the bands 1 610-1 626.5 MHz and 1 675-1 710 MHz are allocated to the MSS (Earth-to-space) and the FS on a co-primary basis by some administrations and in Region 2, respectively;
- s) that the band 2 670-2 690 MHz is allocated to the MSS (Earth-to-space) on a primary basis as of 1 January 2005 (RR No. S5.419), and these and adjoining frequencies are allocated to the FS on a primary basis; until 1 January 2005, the band 2 655-2 690 MHz shall be used by the MSS (Earth-to-space) in all three Regions subject to agreement obtained under the procedure set forth in RR No. S9.21 (RR No. S5.420);
- t) that sharing between the FS and the MSS (Earth-to-space) poses risks of harmful interference to the receiving space stations that increase with the geographic deployment density of fixed stations and the percentage of fixed stations operating on the same frequencies as the space station transponders (see Annex 2),

recommends

- 1 that the following pfd levels at angles of arrival δ (degrees) from geostationary (GSO) space stations in the MSS should be applied as coordination thresholds with respect to stations in the FS (analogue and digital) that operate on the same frequencies (Note 1):

$$\begin{array}{lll}
 P & \text{dB(W/(m}^2 \cdot \text{MHz))} & \text{for } 0^\circ \leq \delta < 5^\circ \\
 P + r(\delta - 5) & \text{dB(W/(m}^2 \cdot \text{MHz))} & \text{for } 5^\circ \leq \delta < 25^\circ \\
 P + 20r & \text{dB(W/(m}^2 \cdot \text{MHz))} & \text{for } 25^\circ \leq \delta \leq 90^\circ
 \end{array}$$

where values for the parameters P (pfd at low angles of arrival) and r (rate of pfd increase with increasing angle of arrival) are given in Table 1 (see Notes 1, 3, 4 and 5):

TABLE 1

Frequency range (MHz)	pfd parameters	
	P (dB(W/(m ² · MHz)))	r (dB/degree)
1 492-1 525	-128	0.5
1 525-1 530	-128	0.5
2 160-2 170	-128	0.5
2 170-2 200	-128	0.5
2 483.5-2 500	-128	0.5
2 500-2 520	-128	0.5
2 520-2 535	-136	0.75

2 that the following additional pfd levels at angles of arrival δ (degrees) from GSO space stations in the MSS should also be applied as coordination thresholds with respect to stations in the FS (analogue systems for telephony only) that operate using the same frequencies (see Note 1):

$$P \quad \text{dB(W/(m}^2 \cdot 4 \text{ kHz))} \quad \text{for } 0^\circ \leq \delta < 5^\circ$$

$$P + r(\delta - 5) \quad \text{dB(W/(m}^2 \cdot 4 \text{ kHz))} \quad \text{for } 5^\circ \leq \delta < 25^\circ$$

$$P + 20r \quad \text{dB(W/(m}^2 \cdot 4 \text{ kHz))} \quad \text{for } 25^\circ \leq \delta \leq 90^\circ$$

where values for the parameters P (pfd at low angles of arrival) and r (rate of pfd increase with increasing angle of arrival) are given in Table 2 (see Notes 1, 3, 4 and 5):

TABLE 2

Frequency range (MHz)	Power flux-density parameters	
	P (dB(W/(m ² · 4 kHz)))	r (dB/degree)
1 492-1 525	-146	0.5
1 525-1 530	-146	0.5
2 160-2 170	-146	0.5
2 170-2 200	-146	0.5
2 483.5-2 500	-146	0.5
2 500-2 520	-146	0.5
2 520-2 535	-154	0.75

3 that for satellites with overlapping transmit frequencies and orbit separations less than 20°, the pfd thresholds specified in § 1 and 2 for the band 2 520-2 535 MHz should be reduced by 3 dB;

NOTE 1 – In cases involving sharing with analogue systems for telephony in the FS, further coordination is only required when the pfd values are equal to or greater than the coordination threshold values in both Tables 1 and 2.

NOTE 2 – The pfd thresholds specified in § 1 and 2 pertain to situations where there is any overlap between the necessary bandwidths of the subject frequency assignments.

NOTE 3 – Pursuant to the coordination process, it may be possible to exceed the pfd levels specified as a result of technical and operating considerations including those in Annex 1. Mobile-satellite system considerations that may facilitate successful coordination are for further study.

NOTE 4 – Based on Recommendation ITU-R F.1246 regarding the reference bandwidth, the pfd values specified in Table 2 for a 4 kHz reference bandwidth are 18 dB lower than the pfd values specified in Table 1 for a 1 MHz reference bandwidth. These values are appropriate to protect analogue FS systems of medium and low capacity (960 channels or less), as explained in Recommendation ITU-R F.1246.

NOTE 5 – The approach of employing both 1 MHz and 4 kHz reference bandwidths for analogue systems for telephony, as adopted in *recommends* 1 and 2, is applicable only to the frequency bands in the 1-3 GHz range shared by the MSS and the FS. This result is based on the fact that the analogue systems in the FS in these bands are generally used for low to medium capacity of 960 channels or less. This approach is not appropriate for other frequency bands where high-capacity analogue radio-relay systems are employed.

ANNEX 1

Fixed system considerations that may facilitate successful coordination

Fixed radio-relay systems may be either analogue or digital. Many are mature systems which have been designed to take advantage of known topographical features, equipment parameters, and propagation characteristics. As such there are not likely to be many situations where changes can be made to a fixed system that can be used to ameliorate an interference potential. However, the following system parameters or mitigation techniques should be reviewed and used to the extent practical towards achieving successful coordination.

1 Antenna considerations

1.1 Antenna orientation of existing stations

In the establishment of the coordination threshold levels in this Recommendation, the orientation of the receiving antennas with respect to the interfering satellites is not specifically taken into account. In detailed coordination, this factor may provide additional significant protection for some receiving stations in the FS.

1.2 Orbital avoidance by planned stations

Discrimination can be achieved by ensuring that substantial off-axis angles are provided between the receive antenna boresights of future fixed stations and the GSO.

1.3 Polarization discrimination

In situations where the antennas of fixed systems use different polarizations (e.g., linear) than those employed by MSS systems (i.e., circular), polarization discrimination may be available (e.g., up to 3 dB) (see Recommendation ITU-R F.1245).

2 Receiver/transmitter considerations

2.1 Frequency offset

Discrimination can be obtained by offsetting channel frequencies of receiving fixed stations and transmitting MSS space stations, where possible. Interference may be at acceptable levels in cases where the necessary bandwidths of the MSS space station and fixed station assignments do not overlap.

2.2 Additional allowance for interference

In the determination of the coordination threshold levels, an allowance of 1 dB is assumed for a reduction in the fade margin, which has a corresponding impact on system availability and performance. However, improved sharing and a successful coordination may be obtained at the expense of fade margin by increasing the allowance for interference from MSS space stations.

2.3 Modulation and bandwidth considerations

The pfd thresholds are specified in 1 MHz and 4 kHz bandwidths. When the fixed system signal is digital or analogue television, the 1 MHz reference bandwidth applies, and when the fixed system signal is analogue telephony, both 1 MHz and 4 kHz reference bandwidths apply.

ANNEX 2

Sharing of frequency bands in the 1-3 GHz range between transmitting stations in the FS and GSO space stations operating in the mobile-satellite (Earth-to-space) service

Studies have shown co-channel sharing to be unworkable between the FS and the MSS (Earth-to-space) in bands that are widely used by transmitting stations in the FS, even in cases where the FS is assumed to avoid pointing its antenna main beam within 4°-6° of the GSO.

Sharing studies have further shown that even for scenarios where the geographic deployment density of transmitting fixed stations is of the order of one station per 12 500 km² to 300 000 km² (moderate to low usage), protection of mobile-satellite space stations would necessitate power limits for the FS that are far more constraining than the limits now specified in RR Article S21. Specifically, it was concluded that co-channel sharing would be feasible only under the following sets of conditions:

- the mobile-satellite space stations employ global beams;
- the total number of fixed stations within the coverage area is limited to 1 250; and
- the maximum e.i.r.p. density of fixed stations is limited to –36 dB(W/4 kHz);

or

- the mobile-satellite space stations employ spot beam antennas (beamwidths of about 6° or less);
- transmitting antennas of fixed stations are not pointed within about 5° of the GSO;
- only point-to-point systems are operating in the FS;
- there are no FS systems operating within the coverage area of the mobile-satellite space station;
- the geographic deployment density of the fixed stations is limited; and
- the maximum e.i.r.p. density of fixed stations is limited to –4.5 to +2.5 dB(W/4 kHz) for a population density of one FS station per 50 000 km² and 300 000 km², respectively.

On the basis that all of these conditions cannot simultaneously be met, it is therefore concluded that co-channel sharing is:

- not feasible for mobile-satellite space stations employing global beam antennas; and
- impractical for space stations employing spot beams (e.g., for subregional or domestic coverage or for multiple beam spacecraft providing global coverage)

due to the low e.i.r.p. density restrictions, the requirement for future fixed stations to avoid the GSO by 5° and the impracticality in developing regulatory controls on the total number of fixed stations.