Annex 1.4.

**Sharing and compatibility studies between FS and other services**

1. **Introduction**

Fixed service often shares frequency bands with other services and sharing conditions with these services were generally developed for bands up to 60 GHz. Due to the more intensive future use of new frequency bands beyond 60 GHz by FS (including frequency bands up to 100 GHz) considerations about sharing and compatibility issues between FS and other services gain in significance.

Many studies of frequency sharing between the FS and other services are addressed by CEPT/ECC and by ITU-R. . In particular sharing between FSS and the FSS is addressed in a number of ITU-R SF-series Recommendations. Many studies on sharing between FS systems and other radio services are covered in F-series Recommendations. Various aspects of these studies are summarized in Table 1. These studies s will provide a fundamental basis and useful references for possible studies for higher frequency bands. Some key considerations depend whether the current or intended FS deployments will be foreseen for usual or high density configuration.

TABLE 1: Summary of sharing and compatibility studies between FS and other services

|  |  |  |
| --- | --- | --- |
| **Other service sharing the same band with FS** | **Frequency bands:** | **ITU-R Rec. or Reports****CEPT/ECC Rec. or Reports** |
| BSS | **1452-1492 MHz**FIXEDMOBILEBROADCASTINGBROADCASTING-SATELLITE | Rec. ITU-R F.1338T/R 13-01 (Annex A) |
| EESS, RAS | **71-76 / 81-86 / 92-94 / 94.1-100 GHz**FIXEDMOBILE | Rec. ITU-R F.2239ECC/REC/(05)07 |
| EESS, SOS, SRS | **2025-2110 / 2200-2290 MHz**FIXEDMOBILE | Rec. ITU-R F.1247T/R 13-01 (Annex C) |
| EESS, SRS | **5250-5350 MHz**MOBILE | Rec. ITU-R F.1613 |
| FSS | **3600-4200 MHz**FIXEDFIXED-SATELLITE | Rec. ITU-R F.1613ERC/REC 12-08 (Annex B - part 2 and part 2) |
| FSS | **10.7-12.75 GHz**FIXEDFIXED-SATELLITE | Rec. ITU-R SF.1482ERC/REC 12-06 |
| FSS | **17.7-19.3 GHz**FIXEDFIXED-SATELLITE | Rec. ITU-R SF.1483ERC/REC 12-03 |
| FSS | **27.5-29.5 GHz**FIXEDFIXED-SATELLITE | Rec. ITU-R SF.1719T/R 13-02 (Annex C)(Channel arrangements)ECC/REC/(11)01 (Note 3)(Block assignment) |
| FSS | **37-40.5/40.5-42.5 GHz**FIXEDFIXED-SATELLITE | Rec. ITU-R F.1669Recommendation T/R 12-01ECC/REC/(01)04 |
| ISS | **25.25-27.5 GHz**FIXEDINTER-SATELLITE | Rec. ITU-R F.1249Rec. ITU-R F.1509T/R 13-02 (Annex B) |
| MS | **1-3 GHz****4-6 GHz**FIXEDMOBILE | Rec. ITU-R F.1334Rec. ITU-R F.1706 |
| MSS | **1-3 GHz**FIXEDMOBILE-SATELLITE | Rec. ITU-R M.1141 Rec. ITU-R M.1142Rec. ITU-R M.1143 |
| RLS | **3.4-3.7 GHz**FIXEDMOBILE-SATELLITE | Rec. ITU-R F.1489 |
| RLS | **4-6 GHz**FIXEDMOBILE | Rec. ITU-R F.1097 |

1. **Interference with the FSS, BSS and MSS systems**

This section deals with interference between terrestrial fixed services (FS) and the fixed- broadcasting- and mobile satellite services. Frequency sharing consideration has become a very important issue for system planners and coordinators, since many parts of the spectrum have recently been allocated to more than one service on a primary basis.

* 1. **Frequency allocations**

WRCs take decisions on changes of the allocation of all relevant radiocommunication services to the various frequency bands. Telecommunication satellite networks are implemented in the framework of the fixed-satellite service (FSS), the broadcasting-satellite service (BSS) and the mobile-satellite service (MSS). The MSS may involve land, maritime and aeronautical mobile-satellite services. FSS in contrast MSS is defined for involving links between points on the earth, which are fixed (as). BSS covers radio and TV broadcast transmissions. For both MSS and BSS a part of the link may be implemented as a feeder link transmission between fixed points of the earth and therefore be operated within the FSS. Any frequency allocation to the FSS may be used for feeder links. In order to promote the efficient use of the spectrum, most of the frequency allocations are shared by several services.

Since the geostationary orbit arc is generally beryond the local horizon, sharing with the **fixed service (FS, i.e. radio-relay links)** is feasible and implemented . The HCM Frequency Table (including the primary allocations) contains a list of frequency bands allocated to the the following services: FIXED (FS), MOBILE (MS), FIXED-SATELLITE (FSS), MOBILE-SATELLITE (MSS), RADIOLOCATION and BROADCASTING.

Where a frequency band i allocated to a single service it is necessary to ensure, that interfering signals between different networks of th service doe not exceed unacceptable limits. a frequency band shared by two or more services, similar methods are used to ensure that stations of secondary service do not cause harmful interference to stations of primary service, and that also interference signals between stations of primary services doe not exceed unacceptable limits.

* 1. **Coordination aspects**

The procedure for frequency coordinationrepresents the basic element of the international radio regulatory arrangement. The provisions of Article 6 stipulate, that if two or more Administrations coordinate the use of individual frequencies in any of the frequency bands covered by Special terms and definitions concerning coordination.

The most important 4 definitions that are applicable in the case of FS/MS stations in bands shared with space services are as follows:

* **coordination area**: the area surrounding an earth station sharing the same frequency band with terrestrial stations beyond which the level of permissible interference will not be exceeded and the coordination is therefore not required.
* **coordination contour**: the line enclosing the coordination area.
* **coordination distance**: by determing the need for coordination the distance on a given azimuth from an earth station sharing the same frequency band with terrestrial stations beyond which the level of permissible interference will not be exceeded and the coordination is therefore not required.
* **permissible interference**: is used for the coordination of frequency assignements between Administrations and refers to the observed or predicted interference, which complies with quantitative interference and sharing criteria contained in the relevant regulations .
1. **Provisions for coordination in the shared bands**

Article 9 (Section II) provides the procedure for effecting coordination. Coordination of terrestrial services in the shared bands shall be effected with other Administrations for the cases described in Table 2.

TABLE 2: Methods for identifying the level of interference

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Reference of Article 9** | **Case** | **Frequency bands of the service for which coor-dination is sought** | **Threshold/****condition** | **Calculation method** | **Remarks** |
| No. **9.16**Terrestrial/ non-GSO | A transmitting station of a terrestrial service within the coordination area of an earth station in a non-GSO satellite network in frequency bands for which a footnote refers to No.9.11A; | Frequency bands for which a footnote refers to No. 9.**11A** | Transmitting terrestrial station is siutuated within the coordination area of a receiving earth station |  | The coordination area of the affected earth station has already been determined using the method of Appendix 7 |
| No**. 9.18**Terrestrial/ GSO/ non-GSO, | A transmitting station of a terrestrial service in the bands referred to in No. 9.17 within the coordination area of an earth station, with the exception of the coordination under Nos. 9.16 and 9.19;      | Frequency bands allocated to FS/MS/FSS | Transmitting terrestrial station is siutuated within the coordination area of a receiving earth station |  | The coordination area of the affected earth station has already been determined using the method of Appendix 7 |
| No. **9.19**Terrestrial/ GSO/non-GSO/ | A transmitting station of a terrestrial service or a transmitting earth station in the FSS (Earth-to-sp) in a frequency band shared on an equal primary basis with the BSS, with respect to typical earth stations included in the service area of a space station in the BSS | Bands listed in No. 9.11, the band 2520-2670 MHz and the band 11.7-12.7 GHz | Necessary bandwidths overlap, and the pfd of the interfering station at the edge of the BSS service area exceeds the permissible level | Check by using the assigned frequencies and bandwidths | See also Article 6 of Appendix 30 |
| No. **9.21**Terrestrial/ GSO/non-GSO/ | A station of a service for which the requirement to seek the agreement of other administrations is included in a footnote to the Table of Frequency Allocations referring to this provision. | Bands indicated in the relevant footnote | Incompatibility established by the use of App. 7, 8, technical Annexes of App. 30, 30A, pfd values in RR | Methods specified in Appendices 7, 8, 30, 30A or other technical provisions |  |

# Establishment of the coordination area of earth stations in a fixed location (9.15/9.17)

Separate coordination contours are produced for transmitting and receiving assignments of an earth station. Depending on the frequency band, type of service and nature of the satellite orbit, coordination areas could be determined by the predetermined coordination distances or computed by using the methods given in Appendix **7**.

Appendix 7 of Radio Regulations (RR) contains procedures and system parameters for calculating an earth station’s coordination area, including predetermined distances.

Brief features of the Appendix 7 are:

* applicable frequency range 100 MHz-105 GHz.
* Three propagation models corresponding to the frequency ranges 105-790 MHz, 790 MHz‑60 GHz and 60-105 GHz.
* Transmitting earth station and receiving earth station are considered separately.
* Different calculation methods to determine the coordination area around an earth station according to different types of space stations (i.e. GSO or non-GSO space station ).
* A method to determine the coordination area around a transmitting earth station with respect to receiving earth stations was added at WRC-2000.
* Auxiliary contours can be drawn for the detailed analysation (as a complementary information subject to an agreement between coordinating Administrations ).
* System parameter tables for unknown terrestrial stations, or for unknown receiving earth stations.
* Predetermined coordination distances for some services and frequency bands.

 For coordination area determination based on the detailed method and not on a predetermined coordination distance, calculations are performed separately for great circle propagation mechanisms (propagation mode (1)) and for scattering from hydrometeors (propagation mode (2)).

For each mode of propagation, interference may arise through a range of propagation mechanisms. Their individual dominance depends on climate, radio frequency, time percentage in question, distance and path topography. At any given point in time, one or more mechanisms may be present and major propagation phenomena considered in the determination of the interference potential are “Diffraction”, “Tropospheric scatter”, “Surface ducting”, “Elevated layer reflection” and “refraction and hydrometeor scatter”, as shown in Figure 1.

In Appendix 7, propagation phenomena are classified into two modes as follows:

* ***Propagation mode (1)*:** propagation phenomena in clear air (tropospheric scatter, ducting, layer reflection/refraction, gaseous absorption and site shielding). These phenomena are confined to propagation along the great-circle path. The diffraction effect is referred to as “site shielding” associated with elevation angle of the earth station. The remainder of the path along each radial is considered to be flat and therefore free of additional diffraction losses. Therefore, it is important to consider the real horizon elevation angle, because the level of attenuation for the propagation mode (1) path loss can be different depending on the *(positive or negative)* horizon elevation angle.
* ***Propagation mode (2)*:** hydrometeor scatter.

Where the earth station antenna beam intersects a rain cell, a common volume may be formed with a terrestrial station beam or an earth station beam. This can be represented by a vertical cylinder filled with hydrometeors that give rise to isotropically scattered signals. The size of the common volume, and the number of scattered signals within that volume, increases as the gain of the earth station antenna decreases.



Figure 1.

The coordination contour is determined by using the greater distance either predicted by the propagation mode (1) or by propagation mode (2) calculations for each azimuth around the coordinating earth station.

The methodology of calculation of the coordination area of an earth station is, obviously, based on the most unfavourable case assumptions as regards parameters of unknown terrestrial or earth stations and its interference potential, such as the maximum transmitting e.i.r.p. and constant value of receiving antenna gain of terrestrial stations in all directions. In reality such worst-case assumptions do not accur.. Practical experience has shown that in many cases the separation distance required for the earth station to be coordinated for all azimuth directions can in fact be substantially less than the coordination distance. This is due to the fact, that terrestrial station antenna gain (or e.i.r.p.), or receiving earth station antenna gain in the relevant direction is signifcantly less than that determined by calculating the coordination contour. In the interest of simplifying coordination, therefore, auxiliary contours are drawn, which use the same method as that used to determine the corresponding main contour.

The minimum required loss shall progressively be reduced by, for example by multiples of 5 dB., below the value derived from the parameters assumed (for example in Tables 7 , 8 or 9 of Appendix **7**) for the corresponding main propagation mode (1) contour and/or main beam avoidance angles of 2.0o, 3.0o, 4.0o or 5.0o, etc. For propagation mode (2) auxiliary contours can be drawn in the same manner as the main coordination contours. For example, if the difference between the actual antenna gain and the gain of the generic antenna is 5 dB, then the –5 dB auxiliary contour in Mode1 should be used. If the main beam of the coordinating earth station does not intersect exactly with the terrestrial station antenna beam, but with the offset of 2.0o, then the 2.0o auxiliary contour in Mode2 should be used.

# Coordination area of mobile earth stations and non-GSO MSS feeder-link earth stations with respect to terrestrial stations (Nos. 9.15/9.17)

The coordination area of mobile earth stations is determined by the service area, in which it is intended to operate typical earth stations, extended in all directions by the coordination distance. Table 10 of Appendix **7** provides the predetermined coordination distances in the case of mobile earth stations in the bands below 1 GHz and between 1 GHz and 3 GHz. Predetermined coordination distances for non-GSO MSS feeder-link earth stations with respect to terrestrial services are also specified in Table 10 of Appendix **7**.

In order to apply this predetermined coordination distance, however, the Administration is kindly requested to carefully review all relevant footnotes in the Article 5 of Radio Regulations related to the planed frequency bands, and then to apply the suitable distance from Table10 with regard to the related terrestrial service.

#  Coordination area of earth stations with respect to other earth stations (operating in the opposite direction of transmission in bidirectionally allocated bands) (No. 9.17A)

## Transmitting earth stations

The procedure for determining the coordination area of a transmitting earth station with respect to other earth stations operating in the opposite direction in bidirectionally allocated bands is described in § 3 of Appendix **7**. Tables 9a and 9b of Annex 7 of Appendix **7** list the parameters required for the determination of the coordination distance of a transmitting earth station with respect to other earth stations (operating in the opposite direction of transmission in bidirectionally allocated bands) (No. 9.**17A**).

## Receiving earth stations

There is no methodology for calculating the coordination area for a receiving earth station with respect to another earth station operating in the opposite direction of transmission in bidirectionally allocated bands. Therefore, the coordination requirement of a receiving earth station with respect to transmitting earth stations operating in bidirectionally allocated bands is determined by using the coordination area information of the existing transmitting earth stations, and any additional coordination area information received from other administrations for planned transmitting earth stations, to verify whether or not the receiving earth station falls within the coordination area of any of those transmitting earth stations of other administrations. Thereafter, the notifying administration shall proceed with the Nos. **9.29/9.31** coordination process as required.

At the notification stage for a receiving earth station with respect to another earth station operating in the opposite direction of transmission in bidirectionally allocated bands or a transmitting terrestrial station with respect to a receiving earth station in equally allocated bands, the Bureau examines the earth station/terrestrial station, whether it is located inside of the coordination area of any other relevant system() of neighbouring countries, which is already recorded in the Master International Frequency Register.

1. **Technical criteria and examination aspects for terrestrial services in shared frequency bands**
	1. **Limitations for terrestrial stations shared with satellite services in the direction from Earth-to space**

Article 21 provides guidance on the choice of sites, frequencies and power limits applicable to terrestrial stations in frequency bands beyond 1 GHz.

Provision 21.1: Sites and frequencies for terrestrial stations and earth stations, operating in frequency bands shared with equal rights between terrestrial radiocommunication and space radiocommunication services, shall be selected having regard to the relevant ITU‑R Recommendations with respect to geographical separation between earth stations and terrestrial stations.

Provision 21.2: As far as practicable, sites for transmitting stations, in the fixed or mobile service, employing maximum values of equivalent isotropically radiated power (e.i.r.p.) exceeding the values given in Table **3** in the frequency bands indicated, should be selected so that the direction of maximum radiation of any antenna will be separated from the geostationary-satellite orbit by at least the angle in degrees shown in the following Table 3, taking into account the effect of atmospheric refraction.

Table 3

|  |  |  |
| --- | --- | --- |
| Frequency band(GHz) | e.i.r.p. value (dBW)(see also Nos. 21.2 and 21.4) | Minimum separation angle with respect to geostationary-satellite orbit (degrees) |
| 1-10 | +35 | 2 |
| 10-15 | +45 | 1.5 |
| 25.25-27.5 | +24 (in any 1 MHz band) | 1.5 |
| Other bands above 15 GHz | +55 | No limit |

In the shared bands, the following general power limits for terrestrial stations are applied:

Provision 21.3: The maximum equivalent isotropically radiated power (e.i.r.p.) of a station in the fixed or mobile service shall not exceed +55 dBW.

Provision 21.4: Where compliance with No. 21.2 for frequency bands between 1 GHz and 10 GHz is impracticable, the maximum equivalent isotropically radiated power (e.i.r.p.) of a station in the fixed or mobile service shall not exceed:

 +47 dBW in any direction within 0.5° of the geostationary-satellite orbit; or

 +47 dBW to +55 dBW, on a linear decibel scale (8 dB per degree), in any direction between 0.5° and 1.5° of the geostationary-satellite orbit, taking into account the effect of atmospheric refraction.

Provision 21.5: The power delivered by a transmitter to the antenna of a station in the fixed or mobile services shall not exceed +13 dBW in frequency bands between 1 GHz and 10 GHz, or +10 dBW in frequency bands above 10 GHz, except as cited in No. 21.5A.    (WRC‑2000)

Provision 21.5A: As an exception to the power levels given in No. 21.5, the sharing environment within which the Earth exploration-satellite (passive) and space research (passive) services shall operate in the band 18.6-18.8 GHz is defined by the following limitations on the operation of the fixed service: the power of each RF carrier frequency delivered to the input of each antenna of a station in the fixed service in the band 18.6-18.8 GHz shall not exceed −3 dBW.     (WRC‑2000)

Provision 21.6: The limits given in Nos. 21.2, 21.3, 21.4, 21.5 and 21.5A apply, where applicable, to the services and frequency bands indicated in Table 21-2 for reception by space stations where the frequency bands are shared with equal rights with the fixed or mobile services:     (WRC‑2000)

Provision 21.7: Transhorizon systems in the 1 700-1 710 MHz, 1 980-2 010 MHz, 2 025-2 110 MHz and 2 200-2 290 MHz bands may exceed the limits given in Nos. 21.3 and 21.5, but the provisions of Nos. 21.2 and 21.4 should be observed. Considering the difficult sharing conditions with other services, administrations are urged to keep the number of transhorizon systems in these bands to a minimum.

**Power limits for earth stations**

**Provision 21.8:** The equivalent isotropically radiated power (e.i.r.p.) transmitted in any direction towards the horizon by an earth station shall not exceed the following limits except as provided in No. 21.10 or 21.11:

 *a)* in frequency bands between 1 GHz and 15 GHz

 +40 dBW in any 4 kHz band for θ ≤ 0°

 +40 + 3 θ dBW in any 4 kHz band for 0° < θ ≤ 5°; and

 *b)* in frequency bands above 15 GHz

 +64 dBW in any 1 MHz band for θ ≤ 0°

 +64 + 3 θ dBW in any 1 MHz band for 0° < θ ≤ 5°,

where θ is the angle of elevation of the nhorizon viewed from the centre of radiation of the antenna of the earth station and measured in degrees as positive above the horizontal plane and negative below it.

Provision 21.9: For angles of elevation of the horizon greater than 5° there shall be no restriction as to the equivalent isotropically radiated power (e.i.r.p.) transmitted by an earth station towards the horizon.

**Power limits from space stations**

The power flux-density at the Earth’s surface produced by emissions from a space station shall not exceed the limit given in able 4.

Table 4.

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency band | Service | Limit in dB(W/m2) for anglesof arrival (δ) above the horizontal plane | Reference bandwidth |
| 0°-5° | 5°-25° | 25°-90° |
| −181.0 | −193.0 + 20 log δ | −213.3 + 35.6 log δ | −150.0 |  |
| 3 400-4 200 MHz | FSS (sp-to-Earth) GSO | −152 | −152 + 0.5(δ − 5) | −142 | 4 kHz |
| 3 400-4 200 MHz | FSS (sp-to-Earth) n-GSO | −138 − *Y*17, 18 | −138 − *Y*+ (12 + *Y* )(δ − 5)/2017, 18 | −126 18 | 1 MHz |
| 4 500-4 800 MHz7 250-7 900 MHz | FSS (sp-to-Earth) GSO Met-satellite (sp-to-Earth)MSS | −152 | −152 + 0.5(δ − 5) | −142 | 4 kHz |
| 5 150-5 216 MHz | FSS (sp-to-Earth) |  | −164 |  | 4 kHz |
| 6 700-6 825 MHz | FSS (sp-to-Earth) | −13714 | −137 + 0.5(δ − 5) | −127 | 1 MHz |
| 6 825-7 075 MHz | FSS (sp-to-Earth) | −154and −134 | −154 + 0.5(δ − 5)and−134 + 0.5(δ − 5) | −144and −124 | 4 kHz1 MHz |
| 8 025-8 500 MHz | EES (sp-to-Earth)SR (sp-to-Earth) | −150 | −150 + 0.5(δ − 5) | −140 | 4 kHz |
| 10.7-11.7 GHz | FSS (sp-to-Earth) GSO | −150 | −150 + 0.5(δ − 5) | −140 | 4 kHz |
| 10.7-11.7 GHz | FSS (sp-to-Earth) non-GSO | −126 | −126 + 0.5(δ − 5) | −116 | 1 MHz |
| 10.7-11.7 GHz11.7-12.5 GHz12.5-12.75 GHz | FSS (sp-to-Earth) non-GSO | −129 18 | −129 + 0.75(δ − 5) 18 | −114 18 | 1 MHz |
| 11.7-12.5 GHz12.5-12.75 GHz | FSS (sp-to-Earth) n-GSO | −124 | −124 + 0.5(δ − 5) | −114 | 1 MHz |
| 12.5‑12.75 GHz  | FSS (sp-to-Earth) GSO | −148 | −148 + 0.5(δ − 5) | −138 | 4 kHz |
| 15.43-15.63 GHz | FSS (sp-to-Earth) | −127 | 5°-20°: −12720°-25°:−127 + 0.56(δ − 20)2 | 25°-29°: −11329°-31°:−136.9 +25 log (δ − 20)31°-90°: −111 | 1 MHz |
| 17.7-19.3 GHz 7, 8 | FSS (sp-to-Earth)Met-satellite (spe-to-Earth) | −115  13, 13Aor−115 − X  12 | −115 + 0.5(δ − 5) 13, 13Aor−115 − *X* + ((10 + *X* )/20)(δ − 5)12 | −105 13, 13Aor−105  12 | 1 MHz |
| 17.7-19.3 GHz 7, 8 | FSS (sp-to-Earth) | **0°-3°** | **3°-12°** | **12°-25°** | −105  13B | 1 MHz |
| −120  13B | −120 + (8/9)(δ − 3) 13B | −112 +(7/13)(δ − 12) 13B |
| 19.3-19.7 GHz | FSS (sp-to-Earth) | **0°-3°** | **3°-12°** | **12°-25°** | −105  13B | 1 MHz |
| −120  13B | −120 + (8/9)(δ − 3) 13B | −112 +(7/13)(δ − 12) 13B |
| 19.3-19.7 GHz 21.4-22 GHz 22.55-23.55 GHz24.45-24.75 GHz25.25-27.5 GHz27.500-27.501 GHz | FSS (sp-to-Earth) BSSEES-satellite (sp-to-Earth) | −115 13A | −115 + 0.5(δ − 5) 13A | −105 13A | 1 MHz |
| 37.5-40 GHz | FSS (sp-to-Earth) n-GSOMSS n-GSO | −120 10, 16 | −120 + 0.75(δ − 5) 10,16 | −105 10, 16 | 1 MHz |
| 37.5-40 GHz | FSS GSOMSS GSO | **0°-5°** | **5°-20°** | **20°-25°** | **25°-90°** | 1 MHz |
| −12716 | −127 + (4/3) (δ − 5) 16 | −107 + 0.4(δ − 20) 16 | −105 16 |
| 0°-5° | 5°-25° | 25°-90° |
| 40-40.5 GHz | FSS | −115 | −115 + 0.5(δ − 5) | −105 | 1 MHz |
| 40.5-42 GHz | FSS n-GSOBSS n-GSO | −11510, 16 | −115 + 0.5(δ − 5)10, 16 | −105  10, 16 | 1 MHz |
| 40.5-42 GHz | FSS GSOBSS GSO | −12016 | **5°-15°** | **15°-25°** | −105  16 | 1 MHz |
| −120 + (δ − 5) 16 | −110 + 0.5(δ − 15)16 |
| −120 + 0.75(δ − 5)10, 16 |
| 42-42.5 GHz | FSS GSO | −12716 | **5°-20°** | **20°-25°** | −10516 | 1 MHz |
| −127 + (4/3)(δ − 5)16 | −107 + 0.4(δ − 20)16 |
| −115 + 0.5(δ − 5) |

1. **Frequency sharing between systems of (GSO) FSS and terrestrial services (FS/MS)**

Frequency sharing between systems of the FSS and FS (MS) cover the following s four possible cases of interference, which are also shown in figure 2:

These are:

 A. From transmitting earth stations to receiving terrestrial stations.

 B. From transmitting terrestrial stations to receiving earth stations.

 C. From transmitting space station (satellite) to receiving terrestrial stations.

 D. From transmitting terrestrial stations to receiving space station (satellite).

Cases A and B are resolved by detailed coordination on case-by-case bases. To identify specific cases requiring detailed coordination ITU-RR provides a procedure for determining the coordination contour around an earth station, within which a terrestrial station might cause, or be subject to harmful interference. Its purpose is an identification trigger for cases, where detailed coordination is needed.

Protection from interference for case C is provided by the adoption of maximum permissible power flux-densities at the Earth’s surface due to a space station in the FSS as provided in the Radio Rregultaions of the ITU-R. Protection from interference for the case D is provided by certain power (e.i.r.p.) and pointing angle restriction for the radio-relay systems.



Figure 2.: Illustration of the geometry associated with the 4 cases of interference.

**6.3 Transmitting Earth stations and receiving terrestrial stations**

The transmitting Earth station is similar to a FS TX station. The radio relay receivers will suffer unacceptable harmful interference, if the threshold degradation is greater then 1 dB. The value of threshold degradation should be determined according to the HCM Agreement.

 **6.4.Transmitting terrestrial stations and receiving Earth stations**

The method of calculating the coordination area as described in the Radio Regulations of ITU-R assumes certain reference values for the parameters of Earth and terrestrial stations.

There is a small probability that the main beam of a terrestrial radio-relay link will be directed towards an earth station so that for the assessment of propagation mode (1) cases it is appropriate to take account of the angular directivity of the terrestrial antenna. A terrestrial station, which antenna main beam does not point towards the Earth station, may be eliminated from further consideration under the condition, that its actual antenna gain towards the Earth station is less then that assumed for the determination of the coordination area. Otherwise detailed calculations must be carried out.

Taking into account that Appendix 7 (RR) methodology provides a worst-case estimation of the required distance, since the FS station() is assumed to point directly toward the Earth station. Taking r the actual pointing direction of the FS station into account will in most situations significantly reduce the coordination distance. Any computational program developed as part of these coordination procedures would need to take into account the FS station antenna orientation and diagramm.

Since there is no general need to protect the satellite receiving station from terrestrial stations (FS or MS),. harmful interference can be treated on a case by case basis with maximum cooperative efforts to solve the interference issue by applying mitigation techniques like shielding and/or power reduction as far as possible .

Note: according to Article 21.8 of the Radio Regulations the power limits for earth stations:

The equivalent isotropically radiated power (e.i.r.p.) transmitted in any direction towards the horizon by an earth station shall not exceed the following limits:

1. in frequency bands between 1 GHz and 15 GHz

 +40 dBW in any 4 kHz band for ϴ < 0°

 +40 + 3 ϴ dBW in any 4 kHz band for 0° < ϴ < 5°; and

1. in frequency bands above 15 GHz

 +64 dBW in any 1 MHz band for ϴ < 0°

 +64 + 3  dBW in any 1 MHz band for 0° < ϴ < 5°where ϴ is the angle of elevation of the horizon viewed from the centre of radiation of the antenna of the earth station and measured in degrees as positive above the horizontal plane and negative below it.

6.5 **Transmitting space station (satellite) and receiving FS stations.**

The interference potential created by a transmitting space station can affect receiving terrestrial stations and receiving earth stations of another satellite network. The interference potential to terrestrial stations is restricted by limitation of the maximum power flux-density produced by a space station on the Earth’s surface.

The power flux-density at the Earth’s surface produced by emissions from a space station, including emissions from a reflecting satellite, for all conditions and for all methods of modulation, shall not exceed the limits given in Table 21-4. These limits relate to the power flux-density, which would be obtained under assumed free-space propagation conditions and which apply to emissions by a space station of the service indicated in frequency bands shared by equal rights with the fixed or mobile service. (see TABLE 4)

6.6 **Transmitting FS stations and receiving space station (satellite).**

Where compliance with Article 21 for frequency bands between 1 GHz and 10 GHz is impracticable, the maximum equivalent isotropically radiated power (e.i.r.p.) of a station in the fixed or mobile service shall not exceed:

* +47 dBW in any direction within 0.5° of the geostationary-satellite orbit; or
* +47 dBW to +55 dBW, on a linear decibel scale (8 dB per degree), in any direction between 0.5° and 1.5° of the geostationary-satellite orbit, taking into account the effect of atmospheric refraction.
1. **Establishment of the coordination area of earth stations in a fixed location (9.15/9.17)**

Separate coordination contours are produced for transmitting and receiving assignments of an earth station. Depending on the frequency band, type of service and nature of the satellite orbit, coordination areas could be determined by the predetermined coordination distances or computed by using the methods given in Appendix 7. (which contains procedures and system parameters for calculating an earth station’s coordination area).

Brief features of the Appendix 7 are:

• the frequency range where it can be used is 100 MHz - 105 GHz;

• three propagation models corresponding to the frequency ranges:

- 105-790 MHz,

- 790 MHz - 60 GHz

- 60-105 GHz;

• transmitting earth station and receiving earth station are considered separately;

• different calculation method to determine the coordination area around an earth station

 according to different type of space stations (i.e. GSO or non-GSO system);

• a method to determine the coordination area around a transmitting earth station with respect to

 receiving earth stations (bidirectional case) was added in WRC-2000;

• auxiliary contours can be drawn for the detailed discussion (as a complementary information

 subject to an agreement between Administrations;

• system parameter tables for the unknown terrestrial or earth stations;

• predetermined coordination distances for some services and frequency bands.

1. **Coordination area of mobile earth stations and non-GSO MSS feeder-link earth stations with respect to terrestrial stations (No. 9.15/9.17)**

The coordination area of mobile earth stations is determined by the service area in which it is intended to operate typical earth stations, extended in all directions by the coordination distance. Table 10 of Appendix 7 provides the predetermined coordination distances in the case of mobile earth stations in the bands below 1 GHz and between 1 GHz and 3 GHz. Predetermined coordination distances for non-GSO MSS feeder-link earth stations with respect to terrestrial services are also specified in Table 10 of Appendix 7. (see Figure 3.)

In order to apply this predetermined coordination distance, however, the Administration is kindly requested to carefully review all relevant footnotes in the Article 5 of Radio Regulations related to the planed frequency bands, and then to apply the suitable distance from Table 10 with regard to the related terrestrial service.



Figure 3.: Illustration of the NGSO/FS systems

1. **Coordination area of earth stations with respect to other earth stations (operating in the opposite direction of transmission in bidirectionally allocated bands) (No. 9.17A)**

**9.1 Transmitting earth stations**

The procedure for determining the coordination area of a transmitting earth station with respect to other earth stations operating in the opposite direction in bidirectionally allocated bands is described in § 3 of Appendix **7**. Tables 9a and 9b of Annex 7 of Appendix **7** list the parameters required for the determination of the coordination distance of a transmitting earth station with respect to other earth stations (operating in the opposite direction of transmission in bidirectionally allocated bands) (No. 9.**17A**).

**9.2 Receiving earth stations**

No methodology exists for calculating the coordination area for a receiving earth station with respect to another earth station operating in the opposite direction of transmission in bidirectionally allocated bands. Therefore, the coordination requirement of a receiving earth station with respect to transmitting earth stations operating in bidirectionally allocated bands is determined by using the coordination area information of the existing transmitting earth stations of your neighbouring countries and any additional coordination area information received from other administrations for their planned transmitting earth stations, to verify whether or not the planned receiving earth station falls within the coordination area of any of those transmitting earth stations of other administrations. Thereafter, the notifying administration shall proceed with the Nos. **9.29/9.31** coordination process as required.

1. **Computer program**

If coordination contours are to be calculated using the detailed methods of Appendix 7,administrations are urged to use the latest version of the computer programs AP7 embedded in GIBC, along with the associated BR software (i.e. ITU Digital World Map (IDWM) and GIMS) that are available in BR IFIC DVD-ROM.

1. **Coordination request**

Coordination information (database (.mdb file) or paper copy of AP4 form, and a copy of AP7 diagram), as discussed in paragraph 6 above, shall be sent (Nos. **9.29, 9.31**) by the requesting administration (Administration A) to all administrations (Administration B) identified using coordination area.

The coordination is, normally, expected to be concluded within a period of four months but may take longer in many cases due to the requirement for detailed interference calculations between the earth station and existing or planned terrestrial stations.

The requesting administration may, therefore, sometimes receive a copy of the diagram indicating the location of existing terrestrial radiocommunication stations and/or the ones planned to be brought into use in the next three years within the coordination area of the earth station, together with relevant basic characteristics and with such suggestions to achieve a satisfactory solution to the problem.

If for any reason an administration cannot act in accordance with the proper coordination procedure, it can seek the assistance of the Bureau with related to provisions No. **9.33**.

1. **Technical examination**

In order to identify the terrestrial or earth stations (operating in the opposite direction of transmission) of Administration B, which could possibly be affected by or affect the earth station of Administration A, a preliminary examination can be effected whereby the frequency overlap is checked.

Where assigned frequency bands of the terrestrial station or the earth station overlap entirely or partially, Administration B can use auxiliary contours which may make it possible to eliminate from detailed coordination terrestrial stations or earth stations that are located in the coordination area and hence have been identified. Any terrestrial station or earth station that lies outside an auxiliary contour and has an antenna gain towards the coordinating earth station that is less than the gain represented by the relevant auxiliary contour need not be considered further as a significant source of, or subject to, interference.

After the above calculations, if the possibility of interference still exists, a more precise examination is required. At this stage more information is needed such as terrain profiles, precise e.i.r.p., sensitivity and type of modulation. It is possible to seek more information, if required, from the other concerned administration by either of the administrations – the one seeking coordination or the one receiving the coordination request – in order to assess the interference to its own assignments as provided for under the provisions of No. **9.54**.

The both administrations may use any other technical method or period if it is required by their agreement (Nos. **9.50.1** and **9.50.2**). After detailed examination, the administrations may or may not be able to reach coordination agreement.

1. **Agreement on coordination reached or continuation of coordination**

In the case where Administration B agrees to the request for coordination, it shall, within four months of the date of dispatch of the coordination data, inform the requesting administration of its agreement (No. **9.51A**). After detailed examination, Administration B might wish to continue the coordination of the earth station by requesting the inclusion of its radiocommunication station into the coordination process.

In that case, it should send to the administration requesting coordination the full characteristics of

 the above-mentioned stations. Moreover, administrations wishing to record the assignments to their terrestrial stations or earth stations operating in the opposite direction of transmission in bidirectionally allocated bands, not yet recorded in the Master Register, may (under Nos. **11.2** or **11.9**) send to the Bureau at the same time all information as specified in Appendix **4** to the Radio Regulations. In this case, the Bureau will take into account the assignments, which are either in operation or will be operational within the next three years (No. **9.52B**).

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| 1. **THE NOTIFICATION OF FREQUENCY ASSIGNMENTS IN THE SPACE SERVICES**
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The Notification of frequency assignments presents the final regulatory step before frequency assignments can be recorded into the Master International Frequency Register (MIFR). The provisions related to Notification of frequency assignments in the non-planned services are primarily stipulated in Article 11 of the Radio Regulations.

According to Nos. 11.2 and 11.9, any frequency assignment to transmitting and receiving stations shall be notified to the Bureau:

a) if the use of that assignment is capable of causing harmful interference to any service of another administration; or

b) if the assignment is to be used for international radiocommunication; or

c) if that assignment is subject to a world or regional frequency allotment or assignment plan which does not have its own notification procedure; or

d) if that assignment is subject to the coordination procedure of Article 9 or involved in such a case; or

e) if it is desired to obtain international recognition for that assignment; or

f) if it is a non-conforming assignment under No. 8.4 and if the administration wishes to have it recorded for information.

One of the conditions for establishing favourable finding to assignments of earth stations with respect to No. 11.32 is that the corresponding assignments of the space station must already be recorded into the MIFR with a favourable No. 11.32 Finding. Therefore, this implies that the notification procedure for an earth station should be initiated only after the notification procedure for the associated space station has commenced or completed.

The Notification procedures contained in Article 11 of the Radio Regulations are basically presented in Appendex 1 to Annex 1.4.

**References:**

* Radio Regulations (Edition 2012)
* ITU-R Recommendations (ITU-R F.1245-1, ITU-R M.1141-2, ITU-R M.1142-2, ITU-R M.1143-3, ITU-R M.1319-2,m ITU-R F.1108-4, ITU-R F.699-7, ITU-R F.1335)
* Appendix 1 to Annex 1.4
* ITU-R Reports (F,S)
* ECC Recommendations
* ECC Reports
* ERC REPORT 25