MOD

RESOLUTION 169 (REV.WRC-23)

Use of the frequency bands 17.7-19.7 GHz and 27.5-29.5 GHz by earth stations in motion communicating with geostationary space stations in the fixed-satellite service

The World Radiocommunication Conference (Dubai, 2023),

considering

a) that there is a need for global broadband mobile-satellite communications, and that some of this need could be met by allowing earth stations in motion (ESIMs) to communicate with space stations of the geostationary-satellite orbit (GSO) fixed-satellite service (FSS) operating in the frequency bands 17.7-19.7 GHz (space-to-Earth) and 27.5-29.5 GHz (Earth-to-space);

b) that appropriate regulatory and interference-management mechanisms are necessary for the operation of ESIMs;

c) that the frequency bands 17.7-19.7 GHz (space-to-Earth) and 27.5-29.5 GHz (Earth-to-space) are also allocated to terrestrial and space services used by a variety of different systems, and these existing services and their future development need to be protected, without the imposition of undue constraints, from the operation of ESIMs;

d) that the ITU Radiocommunication Sector has studied whether aeronautical ESIMs are capable of protecting non-geostationary (non-GSO) mobile-satellite service (MSS) feeder-link satellite receivers in the frequency band 29.1-29.5 GHz,

recognizing

a) that the administration authorizing ESIMs on territory under its jurisdiction has the right to require that the ESIMs referred to above only use those assignments associated with GSO FSS networks which have been successfully coordinated, notified, brought into use and recorded in the Master International Frequency Register with a favourable finding under Article **11**, including Nos. **11.31**, **11.32** or **11.32A**, where applicable;

b) that, for cases of incomplete coordination under No. **9.7** of the GSO FSS network with assignments to be used by ESIMs, the operation of ESIMs on those assignments in the frequency bands 17.7-19.7 GHz and 27.5-29.5 GHz needs to be in accordance with the provisions of No. **11.42** with respect to any recorded frequency assignment which was the basis of the unfavourable finding under No. **11.38**;

c) that any course of action taken under this Resolution has no impact on the original date of receipt of the frequency assignments of the GSO FSS satellite network with which ESIMs communicate or on the coordination requirements of that satellite network;

d) that successful compliance with this Resolution does not oblige any administration to authorize/license any ESIM to operate within the territory under its jurisdiction,

resolves

1 that, for any ESIM communicating with a GSO FSS space station within the frequency bands 17.7-19.7 GHz and 27.5-29.5 GHz, or parts thereof, the following conditions shall apply:

1.1 with respect to space services in the frequency bands 17.7-19.7 GHz and 27.5-29.5 GHz, ESIMs shall comply with the following conditions:

1.1.1 with respect to satellite networks or systems of other administrations, ESIM characteristics shall remain within the envelope characteristics of typical earth stations associated with the satellite network with which the ESIMs communicate;

1.1.2 the use of ESIMs shall not cause more interference and shall not claim more protection than for typical earth stations in this GSO FSS network;

1.1.3 the notifying administration of the GSO FSS network with which the ESIMs communicate shall ensure that the operation of ESIMs complies with the coordination agreements for the frequency assignments of the typical earth station of this GSO FSS network obtained under the relevant provisions of the Radio Regulations, taking into account *recognizing b)* above;

1.1.4 for the implementation of *resolves* 1.1.1 above, the notifying administration for the GSO FSS network with which the ESIMs communicate shall, in accordance with this Resolution, send to the Radiocommunication Bureau (BR) the relevant Appendix **4** notification information related to the characteristics of the ESIMs intended to communicate with that GSO FSS network, together with the commitment that the ESIM operation shall be in conformity with the Radio Regulations, including this Resolution;

1.1.5 upon receipt of the notification information referred to in *resolves* 1.1.4 above, BR shall examine it with respect to the provisions referred to in *resolves* 1.1.1 above and publish the result of such examination in its International Frequency Information Circular (BR IFIC);

1.1.6 for the protection of non-GSO FSS systems operating in the frequency band 27.5-28.6 GHz, ESIMs communicating with GSO FSS networks shall comply with the provisions contained in Annex 1 to this Resolution;

1.1.7 for the protection of non-GSO MSS feeder links of non-GSO systems for which complete coordination information was received before, and for which feeder-link earth stations were in service as of, 28 October 2019 in the frequency band 29.1-29.5 GHz, ESIMs communicating with GSO FSS networks should consider Annex 2 to this Resolution;

1.1.8 ESIMs shall not claim protection from non-GSO FSS systems operating in the frequency band 17.8-18.6 GHz in accordance with the Radio Regulations, including No. **22.5C**;

1.1.9 ESIMs shall not claim protection from broadcasting-satellite service feeder-link earth stations operating in the frequency band 17.7-18.4 GHz in accordance with the Radio Regulations;

1.2 with respect to the protection of terrestrial services to which the frequency bands 17.7-19.7 GHz and 27.5-29.5 GHz are allocated and which are operating in accordance with the Radio Regulations, ESIMs shall comply with the following conditions:

1.2.1 receiving ESIMs in the frequency band 17.7-19.7 GHz shall not claim protection from terrestrial services to which the frequency band is allocated and which are operating in accordance with the Radio Regulations;

1.2.2 transmitting aeronautical and maritime ESIMs in the frequency band 27.5-29.5 GHz shall not cause unacceptable interference to terrestrial services to which the frequency band is allocated and which are operating in accordance with the Radio Regulations, and Annex 3 to this Resolution shall apply;

1.2.3 transmitting land ESIMs in the frequency band 27.5-29.5 GHz shall not cause unacceptable interference to terrestrial services in neighbouring countries to which the frequency band is allocated and which are operating in accordance with the Radio Regulations (see *resolves* 3);

1.2.4 the provisions in this Resolution, including Annex 3, set the conditions for the purpose of protecting terrestrial services from unacceptable interference from aeronautical and maritime ESIMs in neighbouring countries in the frequency band 27.5-29.5 GHz; however, the requirement not to cause unacceptable interference to, or claim protection from, terrestrial services to which the frequency band is allocated and which are operating in accordance with the Radio Regulations remains valid (see *resolves* 4);

1.2.5 for the application of Part II of Annex 3 as referred to in *resolves* 1.2.2 and 1.2.4 above, BR shall examine the characteristics of aeronautical ESIMs with respect to the conformity with the power flux-density (pfd) limits on the Earth's surface specified in Part II of Annex 3 and publish the results of such examination in the BR IFIC;

1.2.6 the notifying administration for the GSO FSS network with which the ESIMs communicate shall send to BR a commitment that, upon receiving a report of unacceptable interference, the notifying administration for the GSO FSS network with which the ESIMs communicate shall follow the procedures in *resolves* 4;

2 that ESIMs shall not be used or relied upon for safety-of-life applications;

3 that the operation of ESIMs within the territory, including territorial waters and territorial airspace, of an administration shall be carried out only if authorized by that administration;

4 that, in the case of unacceptable interference caused by any type of ESIM:

4.1 the administration of the country in which the ESIM is authorized shall cooperate with an investigation on the matter and provide, to the extent of its ability, any required information on the operation of the ESIM and a point of contact to provide such information;

4.2 the administration of the country in which the ESIM is authorized and the notifying administration of the GSO FSS network with which the ESIM communicates shall, jointly or individually, as the case may be, upon receipt of a report of unacceptable interference, take required action to eliminate the interference or reduce it to an acceptable level;

5 that the administration responsible for the GSO FSS satellite network with which ESIMs communicate shall ensure that:

5.1 for the operation of ESIMs, techniques to maintain pointing accuracy with the associated GSO FSS satellite, without inadvertently tracking adjacent GSO satellites, are employed;

5.2 all necessary measures are taken so that ESIMs are subject to permanent monitoring and control by a network control and monitoring centre (NCMC) or equivalent facility in order to comply with the provisions in this Resolution, and are capable of receiving and acting upon at least "enable transmission" and "disable transmission" commands from the NCMC or equivalent facility;

5.3 measures, when required, are taken to limit the operation of ESIMs in the territory, including territorial waters and territorial airspace, under the jurisdiction of the administrations authorizing ESIMs;

5.4 a permanent point of contact is provided for the purpose of tracing any suspected cases of unacceptable interference from ESIMs and to immediately respond to requests from the focal point of the authorizing administration;

6 that the application of this Resolution does not provide regulatory status to ESIMs different from that derived from the GSO FSS network with which they communicate, taking into account the provisions referred to in this Resolution (see *recognizing b)* above);

7 that, if BR is unable to examine, in accordance with *resolves* 1.2.5 above, aeronautical ESIMs with respect to conformity with the pfd limits on the Earth's surface specified in Part II of Annex 3, the notifying administration shall send to BR a commitment that the aeronautical ESIMs comply with those limits;

8 that BR shall formulate a qualified favourable finding under No. **11.31** with respect to the limits contained in Part II of Annex 3, if *resolves* 7 is applied successfully, otherwise it shall formulate an unfavourable finding,

further resolves

that, should an administration authorizing ESIMs agree to pfd levels higher than the limits contained in Part II of Annex 3 within the territory under its jurisdiction, such agreement shall not affect other countries that are not party to that agreement,

instructs the Director of the Radiocommunication Bureau

1 to take all necessary actions to facilitate the implementation of this Resolution, together with providing any assistance for the resolution of interference, when required;

2 to report to future world radiocommunication conferences any difficulties or inconsistencies encountered in the implementation of this Resolution, including whether or not the responsibilities relating to the operation of ESIMs have been properly addressed;

3 to review, if necessary, once the methodology to examine the characteristics of aeronautical ESIMs with respect to conformity with the pfd limits on the Earth's surface specified in Part II of Annex 3 is available, its findings made in accordance with No. **11.31**,

invites administrations

to collaborate for the implementation of this Resolution, in particular for resolving interference, if any,

invites the ITU Radiocommunication Sector

to conduct, as a matter of urgency, relevant studies to determine a methodology with respect to the examination referred to in *resolves* 1.2.5 above,

instructs the Secretary-General

to bring this Resolution to the attention of the Secretary-General of the International Maritime Organization and of the Secretary General of the International Civil Aviation Organization.

ANNEX 1 TO RESOLUTION 169 (REV.WRC-23)

Provisions for earth stations in motion to protect non-geostationary fixed-satellite service systems in the frequency band 27.5-28.6 GHz

1 In order to protect the non-geostationary (non-GSO) fixed-satellite service (FSS) systems referred to in *resolves* 1.1.6 of this Resolution in the frequency band 27.5-28.6 GHz, earth stations in motion (ESIMs) shall comply with the following provisions:

a) the level of equivalent isotropically radiated power (e.i.r.p.) density emitted by an ESIM in a geostationary (GSO) network in the frequency band 27.5-28.6 GHz shall not exceed the following values for any off-axis angle φ which is 3° or more off the main-lobe axis of an ESIM antenna and outside 3° of the GSO arc:

Off-axis angle	*Maximum e.i.r.p. density*
$3° \leq \varphi \leq 7°$	$28 - 25 \log\varphi$ dB(W/40 kHz)
$7° < \varphi \leq 9.2°$	7 dB(W/40 kHz)
$9.2° < \varphi \leq 48°$	$31 - 25 \log\varphi$ dB(W/40 kHz)
$48° < \varphi \leq 180°$	−1 dB(W/40 kHz)

b) for any ESIM operating in the frequency band 27.5-28.6 GHz that does not meet condition *a)* above, outside of 3° of the GSO arc, the maximum ESIM on-axis e.i.r.p. shall not exceed 55 dBW for emission bandwidths up to and including 100 MHz. For emission bandwidths larger than 100 MHz, the maximum ESIM on-axis e.i.r.p. may be increased proportionately.

ANNEX 2 TO RESOLUTION 169 (REV.WRC-23)

Protection of non-geostationary mobile-satellite service feeder links in the frequency band 29.1-29.5 GHz from earth stations in motion

With regard to the non-geostationary (non-GSO) mobile-satellite service (MSS) feeder links referred to in *resolves* 1.1.7 of this Resolution, administrations should consider the provisions in Part A, Part B or Part C below, as appropriate:

A. If an earth station in motion (ESIM) communicating with a geostationary (GSO) fixed-satellite service (FSS) network complies with each of the parameters or operating conditions listed in Table 1 below, coordination may be used to ensure compatibility between the affected non-GSO MSS feeder-link systems in the frequency band 29.1-29.5 GHz and the GSO FSS network with which the ESIM is associated.

TABLE 1

ESIM operational characteristics and parameters

E.i.r.p. density per carrier (single per ESIM)	≤ 35.5 dBW/MHz
Off-axis e.i.r.p. density	as per No. **22.32**
Average carrier burst duty cycle	≤ 10% (averaged over 30 seconds)
Number of transmitting ESIMs in a single satellite beam in a 15 MHz channel	≤ 6

B. If an ESIM communicating with a GSO FSS network does not comply with each of the parameters or operating conditions listed in Table 1 above, but complies with each of the parameters or operating conditions listed in Table 2 below, coordination may be used to ensure compatibility between the affected non-GSO MSS feeder-link systems in the frequency band 29.1-29.5 GHz and the GSO FSS network with which the ESIM is associated. However, depending on the values of these parameters and characteristics in combination, there may need to be an exclusion zone or other constraint(s) on ESIMs developed by the parties and included in the agreement. Until such time as an agreement on coordination is reached, it may be appropriate for administrations to restrict ESIMs from operating within 500 km of a non-GSO MSS feeder-link earth station in any portion of the frequency band 29.1-29.5 GHz used by non-GSO MSS feeder-link earth stations, and to require that ESIMs operate subject to the condition that they do not cause harmful interference.

TABLE 2

ESIM operational characteristics and parameters

E.i.r.p. density per carrier (single per ESIM)	≤ 50 dBW/MHz
Off-axis e.i.r.p. density	as per No. **22.32**
Average carrier burst duty cycle	100% (averaged over 4 hours)
Number of transmitting ESIMs in a single satellite beam in a 15 MHz channel	≤ 12

C. If an ESIM communicating with a GSO FSS network does not comply with each of the parameters or operating conditions listed in Table 1 or Table 2 above, it may be appropriate for administrations to restrict ESIMs from operating within 725 km of the non-GSO MSS feeder-link earth station in any portion of the frequency band 29.1-29.5 GHz used by non-GSO MSS feeder-link earth stations, and to require that any ESIM operations within between 725 and 1 450 km of a non-GSO MSS feeder-link earth station in any portion of the frequency band 29.1-29.5 GHz used by non-GSO MSS feeder-link earth stations be subject to the condition that the ESIMs do not cause harmful interference.

ANNEX 3 TO RESOLUTION 169 (REV.WRC-23)

Provisions for maritime and aeronautical earth stations in motion to protect terrestrial services in the frequency band 27.5-29.5 GHz

1 The parts below contain provisions to ensure that maritime and aeronautical earth stations in motion (ESIMs) do not cause unacceptable interference in neighbouring countries to terrestrial service operations when ESIMs operate in frequencies overlapping with those used by terrestrial services at any time to which the frequency band 27.5-29.5 GHz is allocated and operating in accordance with the Radio Regulations (see also *resolves* 3 of this Resolution).

Part I: Maritime ESIMs

2 The notifying administration of the geostationary (GSO) fixed-satellite service (FSS) network with which a maritime ESIM communicates shall ensure compliance of the maritime ESIM operating within the frequency band 27.5-29.5 GHz, or parts thereof, with both of the following conditions for the protection of terrestrial services to which the frequency band is allocated within a coastal State:

2.1 The minimum distance from the low-water mark as officially recognized by the coastal State beyond which maritime ESIMs can operate without the prior agreement of any administration is 70 km in the frequency band 27.5-29.5 GHz. Any transmissions from maritime ESIMs within the minimum distance shall be subject to the prior agreement of the coastal State concerned.

2.2 The maximum maritime ESIM equivalent isotropically radiated power (e.i.r.p.) spectral density towards the horizon shall be limited to 24.44 dB(W/14 MHz). Transmissions from maritime ESIMs with higher e.i.r.p. spectral density levels towards the territory of any coastal State shall be subject to the prior agreement of the coastal State concerned.

Part II: Aeronautical ESIMs

3 The notifying administration of the GSO FSS satellite network with which an aeronautical ESIM communicates shall ensure compliance of the aeronautical ESIM operating within the frequency band 27.5-29.5 GHz, or parts thereof, with all of the following conditions for the protection of terrestrial services to which the frequency band is allocated:

3.1 When within line-of-sight of the territory of an administration, and above an altitude of 3 km, the maximum power flux-density (pfd) produced at the surface of the Earth on the territory of an administration by emissions from a single aeronautical ESIM shall not exceed:

$$pfd(\theta) = -124.7 \quad (dB(W/(m^2 \cdot 14\ MHz))) \quad for \quad 0° \le \theta \le 0.01°$$

$$pfd(\theta) = -120.9 + 1.9 \cdot \log\theta \quad (dB(W/(m^2 \cdot 14\ MHz))) \quad for \quad 0.01° < \theta \le 0.3°$$

$$pfd(\theta) = -116.2 + 11 \cdot \log\theta \quad (dB(W/(m^2 \cdot 14\ MHz))) \quad for \quad 0.3° < \theta \le 1°$$

$$pfd(\theta) = -116.2 + 18 \cdot \log\theta \quad (dB(W/(m^2 \cdot 14\ MHz))) \quad for \quad 1° < \theta \le 2°$$

$$pfd(\theta) = -117.9 + 23.7 \cdot \log\theta \quad (dB(W/(m^2 \cdot 14\ MHz))) \quad for \quad 2° < \theta \le 8°$$

$$pfd(\theta) = -96.5 \quad (dB(W/(m^2 \cdot 14\ MHz))) \quad for \quad 8° < \theta \le 90.0°$$

where θ is the angle of arrival of the radio-frequency wave (degrees above the horizon).

3.2 When within line-of-sight of the territory of an administration, and up to an altitude of 3 km, the maximum pfd produced at the surface of the Earth on the territory of an administration by emissions from a single aeronautical ESIM shall not exceed:

$$pfd(\theta) = -136.2 \quad (dB(W/(m^2 \cdot 1\ MHz))) \quad for \quad 0° \le \theta \le 0.01°$$

$$pfd(\theta) = -132.4 + 1.9 \cdot \log\theta \quad (dB(W/(m^2 \cdot 1\ MHz))) \quad for \quad 0.01° < \theta \le 0.3°$$

$$pfd(\theta) = -127.7 + 11 \cdot \log\theta \quad (dB(W/(m^2 \cdot 1\ MHz))) \quad for \quad 0.3° < \theta \le 1°$$

$$pfd(\theta) = -127.7 + 18 \cdot \log\theta \quad (dB(W/(m^2 \cdot 1\ MHz))) \quad for \quad 1° < \theta \le 12.4°$$

$$pfd(\theta) = -108 \quad (dB(W/(m^2 \cdot 1\ MHz))) \quad for \quad 12.4° < \theta \le 90°$$

where θ is the angle of arrival of the radio-frequency wave (degrees above the horizon).

3.3 An aeronautical ESIM operating within the territory of an administration that has authorized fixed-service and/or mobile-service operation in the same frequency bands shall not transmit in these frequency bands without prior agreement of that administration (see also *resolves* 3 of this Resolution).

4 The maximum power in the out-of-band domain should be attenuated below the maximum output power of the aeronautical ESIM transmitter as described in the most recent version of Recommendation ITU-R SM.1541.

5 Higher pfd levels than those provided in 3.1 and 3.2 above produced by aeronautical ESIMs on the surface of the Earth within an administration shall be subject to the prior agreement of that administration (see also *further resolves* of this Resolution).