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| **US Radiocommunication Sector****FACT SHEET** |
| **Study Group:** USWP 7B | **Document No:** US7B\_27\_025\_NC |
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| **Document Title:** Draft Revision of Recommendation ITU-R SA.2141 *Characteristics of space research service systems in the frequency range 14.8-15.35 GHz*  |
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| **Purpose:** To finalize updates to the characteristics of SRS systems in the 14.8 – 15.35 GHz band documented in Recommendation ITU-R SA.2141 consistent with the SRS constraints in Resolution **678** **(WRC-23)** and footnote [**5.A113**].  |
| **Abstract:** As part of the work in association with WRC-23 agenda item 1.13, changes were made to the RR to upgrade allocations to the SRS in 14.8 – 15.35 GHz band from secondary to primary status. The upgrade encompasses allocations in the (s-s), (s-E), and (E-s) directions. The status upgrades for SRS are subject to power flux density limitations which may influence the design of future SRS systems. At the September 2024 WP 7B meeting, a proposal was considered to revise the SRS system characteristics contained in Recommendation ITU-R SA.2141 consistent with the pfd constraints in Resolution **678** **(WRC-23)**. This contribution is intended to finalize the work on revising the Recommendation and sent it to SG7.  |
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| DRAFT REVISION OF RECOMMENDATION ITU-R SA.2141  |
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| Characteristics of space research service systemsin the frequency range 14.8-15.35 GHz |

This document provides additional revisions to the Recommendation [ITU-R SA.2141-0](https://www.itu.int/rec/R-REC-SA.2141/en) which provides characteristics of space research service (SRS) systems operating in the 14.8-15.35 GHz range. This Recommendation was developed to support studies performed under WRC-23 agenda item 1.13 which examined sharing and compatibility between incumbent services and SRS systems operating downlinks, uplinks, and crosslinks in this band.

For some of the SRS direct downlink scenarios studied, information on existing SRS systems was incomplete or unavailable. For these cases, a set of Earth station parameters was developed which was just sufficient to close the link and meet the recommended SRS pfd limits given in Recommendation [ITU-R SA.1626](https://www.itu.int/rec/R-REC-SA.1626/en). This pfd limit was GSO SRS systems is specified as follows:

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| Limit (dB(W/m2)) in 1 MHz bandwidth for angleof arrival, δ, above the horizontal plane |
| 0°-5° | 5°-25° | 25°-90° |
| –126 | –126 + 0.5(δ – 5) | –116 |

Similarly, the pfd limit for non-GSO SRS systems is specified as follows.

|  |
| --- |
| Limit (dB(W/m2)) in 1 MHz bandwidth for angleof arrival, δ, above the horizontal plane |
| 0°-5° | 5°-25° | 25°-90° |
| –124 | –124 + 0.5(δ – 5) | –114 |

As a consequence of agenda item 1.13 (WRC-23), the SRS allocation in the band was upgraded to primary status subject to a number of constraints to protect incumbent service systems. For SRS downlinks, Resolution **678 (WRC-23)** established a more restrictive power flux density limit of −138 dB(W/(m2 ‧ MHz)). This contribution proposes the following modifications to the SRS downlink characteristics in Recommendation ITU-R SA.2141:

– Reduction of SRS spacecraft e.i.r.p. where necessary to meet the more constrained SRS downlink pfd requirement.

– Adjustment of SRS earth station parameters where necessary to provide for closure of the downlink.

Table 1 of Annex 1 to Recommendation ITU-R SA.2141 documents the technical and operational system characteristics for the space research service in the 14.8-15.35 GHz band. Revisions to the characteristic in this table are proposed. Revisions are also made to the *considerings*.

This contribution proposes to finalize it at the current WP7B meeting and submit it to Study Group 7.

ATTACHMENT

DRAFT REVISION OF RECOMMENDATION ITU-R SA.2141-0

**Characteristics of space research service systems
in the frequency range 14.8-15.35 GHz**

(2025)

**Scope**

This Recommendation provides technical and operational system characteristics for the space research service in the 14.8-15.35 GHz band. These characteristics should be considered in sharing and compatibility studies.

**Keywords**

System characteristics, Space Research Service (SRS), space-to-Earth, Earth-to-space, space-to-space, forward feeder link, Data Relay Satellites (DRS)

**Related ITU-R Recommendations and Reports**

Recommendation [ITU-R SA.364-6](https://www.itu.int/rec/R-REC-SA.364/en) – Preferred frequencies and bandwidths for manned and unmanned near-Earth satellites of the space research service

Recommendation [ITU-R SA.510-3](https://www.itu.int/rec/R-REC-SA.510/en) – Feasibility of frequency sharing between the space research service and other services in bands near 14 and 15 GHz Potential interference from data relay satellite systems

Recommendation [ITU-R SA.609-2](https://www.itu.int/rec/R-REC-SA.609/en) – Protection criteria for radiocommunication links for manned and unmanned near-Earth research satellites

Recommendation [ITU-R SA.1018-1](https://www.itu.int/rec/R-REC-SA.1018/en) – Hypothetical reference system for systems comprising data relay satellites in the geostationary orbit and user spacecraft in low Earth-orbits

Recommendation [ITU-R SA.1019-1](https://www.itu.int/rec/R-REC-SA.1019-1-201707-I/en) – Frequency bands and transmission directions for data relay satellite networks/systems

Recommendation ITU-R [SA.1155-2](https://www.itu.int/rec/R-REC-SA.1155-2-201707-I/en) – Protection criteria related to the operation of data relay satellite systems

Recommendation ITU-R [SA.1414-2](https://www.itu.int/rec/R-REC-SA.1414-2-201707-I/en) – Characteristics of data relay satellite systems

Recommendation ITU-R [SA.1626-1](https://www.itu.int/rec/R-REC-SA.1626-1-201312-I/en) – Feasibility of sharing between the space research service (space-to-Earth) and the fixed and mobile services in the band 14.8-15.35 GHz.

The ITU Radiocommunication Assembly,

*considering*

*a)* that the frequency band 14.8-15.35 GHz is allocated on a primary basis to the fixed and mobile services, and on a primary basis to the SRS subject to a number of constraints;

*b)* that the SRS (passive) and Earth exploration-satellite service (EESS) (passive) are allocated on a secondary basis by No. **5.339** of the Radio Regulations (RR) in the 15.20-15.35 GHz band;

*c)* that the SRS (passive), EESS (passive), and radio astronomy services are allocated on a primary basis in the 15.35-15.4 GHz band subject to No. **5.340** and No. **5.511** of the RR;

*d)* that data relay satellite systems operated by multiple administrations make use of the 14.8‑15.35 GHz band both for inter-orbit user links (space-to-space) and feeder uplinks (Earth-to-space);

*e)* that requirements exist for wideband SRS downlinks to transmit future high data rate scientific data;

*recognizing*

*a)* that the frequency band 14.8-15.35 GHz is currently used by data relay satellites for inter-satellite links, which permits the establishment of communications with satellites in non-geostationary orbits (non-GSO), including crewed flights in the SRS;

*b)* that the frequency band 14.8-15.35 GHz is also used for existing high-speed data links from non-GSO satellites within the SRS, and is planned for use in future systems;

*c)* that these satellites are needed for the operation of telescopes and other passive instruments used for measuring such phenomena as the Earth’s magnetosphere and solar flares,

*recommends*

that the technical and operational system characteristics for the space research service in the 14.8‑15.35 GHz band detailed in Annex 1 should be considered in sharing and compatibility studies.

**Annex 1

Technical and operational system characteristics
for the space research service in the 14.8-15.35 GHz band**

**1 Introduction**

Space Research Service (SRS) systems use the 14.8-15.35 GHz band for the following applications:

– direct data downlinks from SRS missions (using a variety of orbit types) to earth stations located globally,

– Earth-to-space feeder uplinks from Data Relay Satellite (DRS) system earth stations to GSO data relay system satellites,

– space-to-space inter-orbit links from the user spacecraft to the GSO DRS satellites.

The characteristics of each of these are discussed below.

**2 Characteristics of SRS direct data downlinks in the 14.8-15.35 GHz band**

It is expected that SRS missions employing direct data downlinks in this band will be limited in number, with an estimated three to five satellites per year worldwide. These will generally be deployed in low-Earth orbit, with either polar or equatorial inclination with some at geostationary altitudes and others at HEO orbits or at the L1 or L2 libration points, as well as in Lunar Orbits or at the Lunar Surface. For most of these SRS mission orbit types, the characteristics of the SRS satellites transmitting direct data downlinks are reflected in the link budgets given in Table 1. For the SRS S/C in Lunar orbits or at the Lunar Surface, link budget parameters will vary depending on operational needs and available advanced modulation and coding techniques; however, the PFD on the Earth’s surface would not exceed levels specified in Recommendation ITU-R [SA.1626](https://www.itu.int/rec/R-REC-SA.1626/en).

In most cases, the links were assumed to support a data rate of 400 Mbit/s on the space‑to‑Earth link, although some links support up to 1.2 Gbit/s. The e.i.r.p. spectral density was adjusted so that the pfd limits of Recommendation ITU‑R [SA.1626](https://www.itu.int/rec/R-REC-SA.1626/en) would be satisfied at all elevation angles. The radiation pattern of the receiving antenna of the SRS earth station was assumed to conform to Recommendation ITU‑R [SA.509](https://www.itu.int/rec/R-REC-SA.509/en). Sharing feasibility was assessed on the basis of the protection criteria given in Recommendation ITU-R [SA.609](https://www.itu.int/rec/R-REC-SA.609/en).

Annex 1

TABLE 1

Example high-rate direct data downlink SRS mission link budgets

| Case | Non-GSO 800 km alt @ 5 deg ES ant elev | Non-GSO 800 km alt @ 10 deg ES ant elev | Non-GSO 800 km alt @ 90 deg ES ant elev | GSO @ 10 deg elev | HEO | HEO | L1/L2 | L1/L2 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Frequency (GHz) | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15, 15.2 |
| Wavelength (m) | 0.020 | 0.020 | 0.020 | 0.020 | 0.020 |  | 0.020 |  |
| Polarization | RHCP or LHCP |
| Satellite apogee (km) | 800 | 800 | 800 | 35 785 | 300 000 | 300 000 | 1 500 000 | 1 500 000 |
| Satellite perigee (km) | 800 | 800 | 800 | 35 785 | 500 | 500 | 1 500 000 | 1 500 000 |
| Data rate (Mbit/s) | 400 | 400 | 400 | 400 | 400 | 320 | 100 | 600 per channel |
| Modulation method | QPSK Uncoded |  | QPSK Uncoded | 8PSK |
| S/C transmit power (dBW) | ‒7.0 | ‒7.0 | ‒7.0 | 8.5 | 5.0 | 11.8 | 13 | 23 |
| S/C transmit filter, cable loss (dBW) | −0.5 | −0.5 | −0.5 | −0.5 | −0.5 | −0.5 | −0.5 | −0.5 |
| S/C transmit antenna diameter (m) | 0.1 | 0.1 | 0.1 | 0.86 | 0.6 | 1.5 | 1.5 | 2.3 |
| S/C transmit antenna efficiency | 0.5 | 0.5 | 0.5 | 0.55 | 0.6 | 0.6 | 0.6 | 0.6 |
| S/C transmit antenna gain (dBi) | 20.9 | 20.9 | 20.9 | 40.0 | 37.3 | 45 | 45.2 | 49 |
| S/C transmit e.i.r.p. (dBW) | 13.4 | 13.4 | 13.4 | 48.0 | 41.8 | 55.8 | 57.7 | 71.5 |
| S/C peak e.i.r.p. density (dBW/MHz) | ‒9.6 | ‒9.6 | ‒9.6 | 25.0 | 18.8 | 35.8 | 40.7 | 48.5 |
| Path length (km) | 2 784 | 2 367 | 800 | 40 585 | 20 000 | 20 000 | 1 505 257 | 1 505 257 |
| Free space path loss (dB) | 184.9 | 183.5 | 174.0 | 208.1 | 225.5 | 225.5 | 239.5 | 239.5 |
| 10\*log(4 \* π \* *d*2) | 139.9 | 138.5 | 129.1 | 163.2 | 157.0 | 157.0 | 194.5 | 194.5 |
| ES receive elevation angle (degree) | 5.0 | 10.0 | 90.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 |
| Pfd limit dB(W/(m2 ‧ MHz))) | ‒138 | ‒138 | ‒138 | ‒138 | ‒138 | ‒138 | ‒138 | ‒138 |

TABLE 1 (*end*)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Case | Non-GSO 800 km alt @ 5 deg ES ant elev | Non-GSO 800 km alt @ 10 deg ES ant elev | Non-GSO 800 km alt @ 90 deg ES ant elev | GSO @ 10 deg elev | HEO | HEO | L1/L2 | L1/L2 |
| Pfd on Earth’s surface (dB(W/(m2 ‧ MHz))) | ‒149.5 | ‒148.1 | ‒138.7 | ‒138.2 | ‒138.2 | −161.7 | −153.8 | −147.3 |
| ES receive antenna diameter | 18.0 | 18.0 | 18.0 | 9.0 | 7.0 | 12.0 | 34.0 | 32.0 |
| ES receive antenna efficiency | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| ES receive antenna gain (dBi) | 67.5 | 67.5 | 67.5 | 61.5 | 59.3 | 64.0 | 73.0 | 72.5 |
| Beam-edge allowance, rain and atmospheric loss (dB) | −3.0 | −3.0 | −3.0 | −3.0 | −4.0 | −4.0 | −4.0 | −4.0 |
| ES receiver system noise temperature (deg K) | 150.0 | 150.0 | 150.0 | 150.0 | 150.0 | 150 | 150.0 | 150 |
| No (dBW/Hz) | −206.8 | −206.8 | −206.8 | −206.8 | −206.8 | −206.8 | −206.8 | −206.8 |
| Receiver losses (dB) | −1.0 | −1.0 | −1.0 | −1.0 | −1.0 | −1.0 | −1.0 | −1.0 |
| Received *Eb/No* (dB) | 13.8 | 15.2 | 24.7 | 19.2 | 15.9 | 17.7 | 12.5 | 18.5 |
| Theoretical *Eb/No* (1E-6 BER) (dB) | 10.5 | 10.5 | 10.5 | 10.5 | 10.5 | 10.5 | 10.5 | 15 |
| Required *Eb/No* (1E-6 BER) (dB) | 11.5 | 11.5 | 11.5 | 11.5 | 11.5 | 11.5 | 11.5 | 16 |
| *Eb/No* margin (dB) | 2.3 | 3.7 | 13.2 | 7.7 | 4.4 | 6.2 | 1.0 | 2.5 |
| Note: For the SRS S/C in HEO orbit, the pfd margin is calculated at an assumed minimum transmit altitude of 20 000 km and the link margin is calculated at a maximum range of 300 000 km. |

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