

NARRATIVE DESCRIPTION: ELS FILE NO. 2486-EX-ST-2023

SUMMARY

Space Exploration Holdings (“SpaceX”) requests Special Temporary Authority to operate up to twelve SpaceX earth stations operating in the Ka-band aboard autonomous, U.S.-flagged drone ships while embarked in U.S. territorial waters in the North Atlantic Ocean and Pacific Ocean from January 1, 2024 to June 29, 2024. SpaceX would operate no more than four earth stations per vessel under this authorization at any given time. This experiment will enable SpaceX to test antennas onboard SpaceX’s autonomous drone ships in the Ka-band.

Each earth station will communicate only with those SpaceX satellites that are visible on the horizon above a minimum elevation angle and that observe the appropriate angular separation from the GSO arc. The earth station will track SpaceX’s satellites passing within their field of view. During testing, communications with the satellites will be limited to a minimum elevation of 25 degrees above the horizon at all times. As the earth station steers the transmitting beam, it automatically changes the power to maintain a constant level at the receiving antenna of its target satellite to the extent possible, compensating for variations in antenna gain and path loss associated with the steering angle. For purposes of the STA Form accompanying this application, SpaceX has supplied the highest transmit power figures and lowest gain figures, consistent with the other gateway hardware the Commission has already approved.¹ Table 1 summarizes the technical specifications of SpaceX's proposed earth stations. These earth stations will comply with the operational requirements specified in 47 C.F.R. § 25.228.

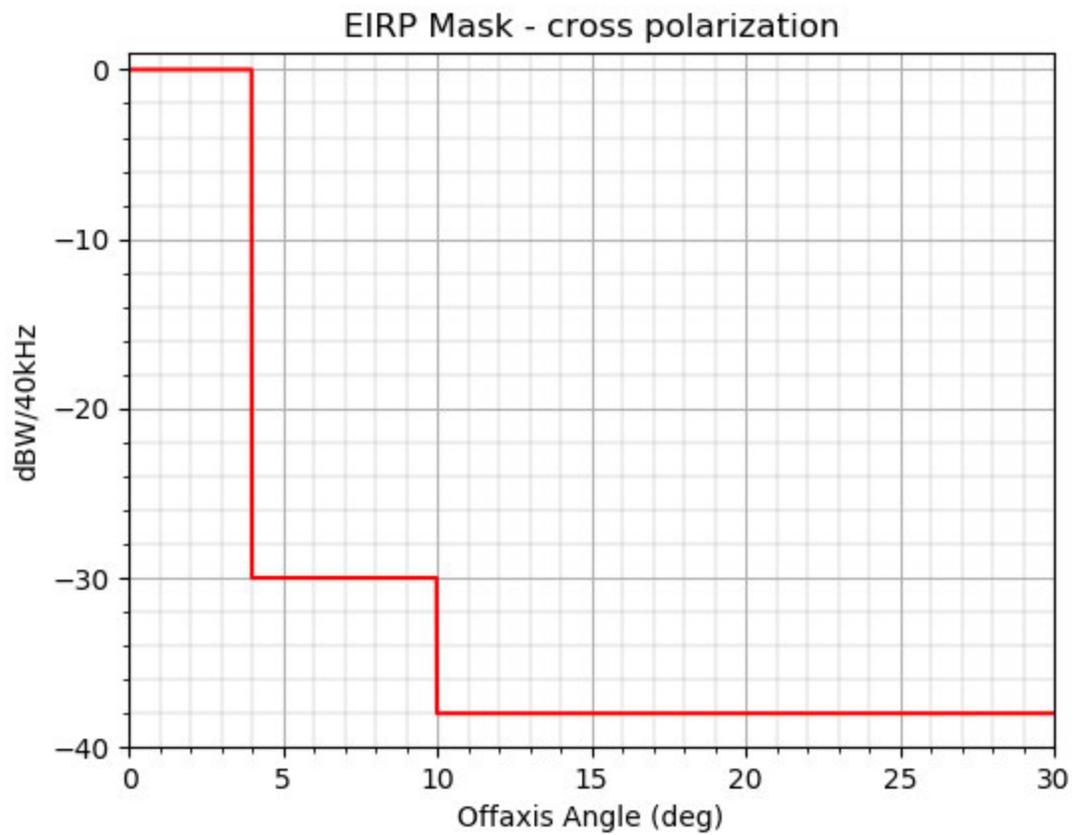
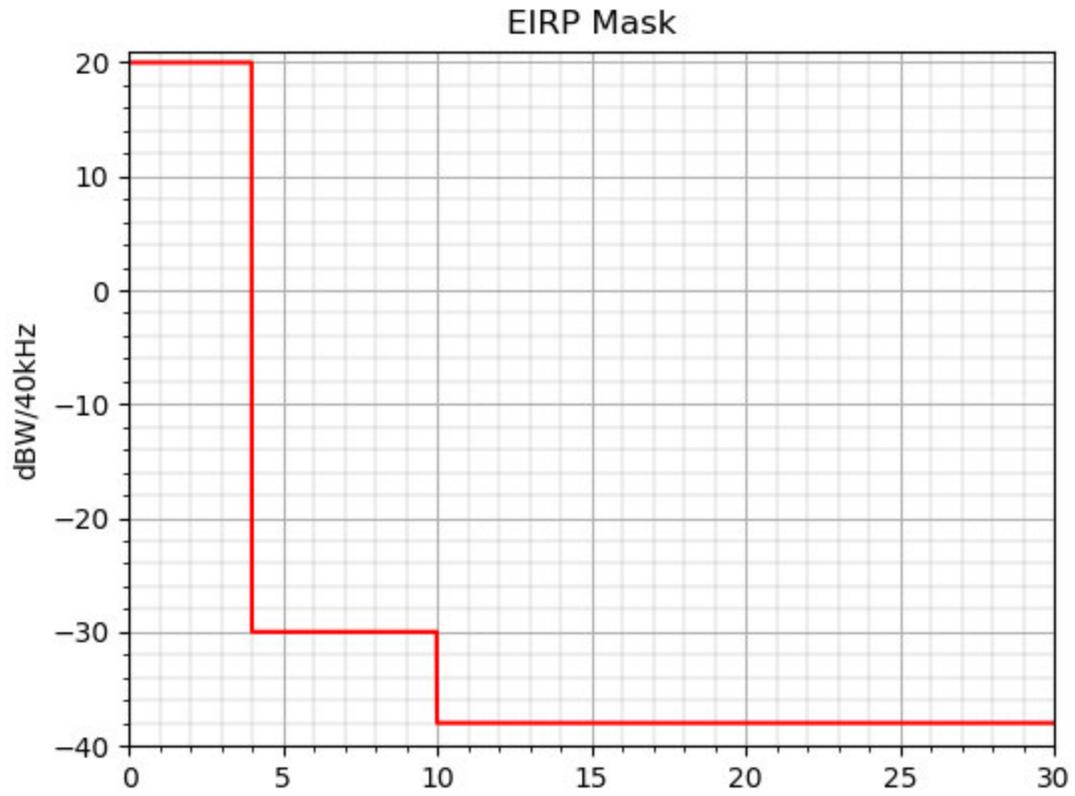
These experiments will not change the operation of SpaceX spacecraft. As discussed below, these proposed operations will not adversely affect any other authorized spectrum user, including geostationary orbit (“GSO”) satellite systems and terrestrial services.

¹ See e.g., Grant, ICFS File No. SES-LIC-20210729-01285 (May 16, 2022); Grant, ICFS File No. SES-LIC-20211027-01751 (Apr. 22, 2022); Grant, ICFS File No. SES-LIC-20201021-01160 (Feb. 24, 2022); Grant, ICFS File No. SES-LIC-20200327-00326 (Feb. 22, 2022); Grant, ICFS File No. SES-LIC-20210412-00666 (Feb. 3, 2022); Grant, ICFS File No. SES-LIC-20210601-00878 (Feb. 3, 2022).

| Link Type | Frequency | Modulation | Emission Designator | Max. EIRP per Carrier |
|-------------------------------------|------------------|-------------------|----------------------------|------------------------------|
| Broadband Downlink (space-to-Earth) | 17.8-18.6 GHz | Up to 64 QAM | 480MD7W | N/A |
| Broadband Downlink (space-to-Earth) | 18.8-19.3 GHz | Up to 64 QAM | 480MD7W | N/A |
| Broadband Uplink (Earth-to-space) | 28.6-29.1 GHz | Up to 64 QAM | 480MD7W | 60.5 dBW |
| Broadband Uplink (Earth-to-space) | 29.5-30 GHz | Up to 64 QAM | 480MD7W | 60.5 dBW |

Table1: Starlink Earth Station Characteristics

The EIRP masks for these proposed earth stations, for co-polarized and cross-polarized signals, are set forth below.



INTERFERENCE PROTECTION

The Commission has allocated the Ka-band that SpaceX proposes to use for uplink communications (28.6-29.1 GHz and 29.5-30 GHz) on a primary basis to FSS. These bands are both allocated exclusively for Earth-to-space satellite communications, with 28.6-29.1 GHz allocated exclusively to FSS and 29.5-30 GHz allocated to FSS and MSS. The 18.3-18.6 GHz downlink band is exclusively allocated for FSS space-to-Earth communications. The 17.8-18.3 GHz band downlink band is allocated for FSS space-to-Earth communications on a secondary basis. Notably, the proposed earth stations would not transmit in these downlink bands and thus could not cause any interference to other operators using those bands.

SpaceX currently operates an extensive network of fixed gateway earth stations in a superset of these bands and plans to use this licensed gateway hardware for testing under this authorization.² The earth station operations proposed in this application will use many of the same techniques to prevent harmful interference to other operators, such as compliance with PFD and EPFD limits, as detailed below. Moreover, SpaceX will not operate in bands allocated to the Upper Microwave Flexible Use Service, further minimizing the risk of harmful interference. Finally, SpaceX will leverage its advanced network management software to maintain pointing accuracy during the experiment and avoid harmful interference to other satellite and terrestrial operators. These techniques are similar those that SpaceX has taken for its licensed ESIMs in the 14.0-14.5 GHz (uplink) and 10.7-12.7 GHz (downlink) bands.

Geostationary Satellite Orbit Systems

The Commission has designated NGSO FSS systems as primary in the 28.6-29.1 GHz band, such that GSO systems “shall not cause harmful interference to, or claim protection from” NGSO FSS systems.³ Nonetheless, SpaceX will operate these earth stations in a manner similar to its other gateway earth stations to protect GSO systems. The proposed operations in the 29.5-30.0 GHz band will protect GSO systems from harmful interference by operating within the ITU EPFD limits that apply to the SpaceX network as a whole, which the Commission has concluded “will adequately protect GSO FSS networks.”⁴ Here, the applicable ITU EPFD limits are provided in Article 22 and Resolution 76 of the ITU Radio Regulations, which require the assessment of a satellite system as a whole to demonstrate that the probability of emissions exceeding certain levels remain within specified regulatory limits.

² *See id.*

³ 47 C.F.R. § 2.106 n.NG165.

⁴ *Amendment of Parts 2 and 25 of the Commission's Rules to Permit Operation of NGSO FSS Systems Co-Frequency with GSO and Terrestrial Systems in the Ku-Band Frequency Range*, 16 FCC Rcd. 4096, ¶ 77 (2000) (concluding that implementation of EPFD limits “will adequately protect GSO FSS networks”). *See also* 47 C.F.R. § 25.289 (NGSO satellite systems that comply with EPFD limits will be deemed not to cause unacceptable interference to any GSO network.).

SpaceX has demonstrated that its NGSO system will comply with these EPFD limits, and doing so is a condition of its space-station authorization.⁵ The earth stations SpaceX seeks to operate in this application will operate within those system-wide EPFD limits.⁶ In addition, the proposed operations will comply with the FCC's requirements in these bands to ensure that motion of the earth station will not cause it to inadvertently exceed interference protection limits.

Fixed-Service Systems

Similar to protection of GSO systems, the ITU has adopted PFD limits (codified in Article 21 of the ITU Radio Regulations) that limit the energy of satellite downlink transmissions to protect terrestrial services. The Commission has concluded that compliance with these PFD limits is sufficient to protect terrestrial fixed-service operators from harmful interference.⁷ Nothing about the operation of the proposed earth stations will affect the SpaceX space-station network compliance with these downlink limits ensuring that Fixed Service licensees will continue to be protected.

NGSO Systems

The SpaceX NGSO FSS system, including operations under the authorization requested herein, will at all times comply with Section 25.261(c) which governs spectrum sharing between NGSO operators. Beyond the requirements of Section 25.261, the SpaceX system uses steerable and shapable beams as well as satellite diversity, which will often allow SpaceX to choose from multiple satellites capable of serving any one point on the ground. These advanced capabilities will allow SpaceX to minimize the potential for in-line events involving these or any other SpaceX earth stations.

TDRSS and Radio Astronomy

SpaceX will comply with its obligations to avoid and/or coordinate with NASA TDRSS and radio astronomy facilities as necessary to avoid harmful interference to these services.⁸

⁵ See *Space Exploration Holdings, LLC*, 36 FCC Rcd. 7995, ¶ 97(l) (2021); 47 C.F.R. § 25.115(f)(1) (incorporating certification requirement in 47 C.F.R. § 25.146(a)(2)).

⁶ *Id.* Notably, the Commission does not require the submission of antenna patterns for blanket-licensed NGSO earth stations, as the EIRP mask is sufficient to verify compliance with EPFD limits and other interference-protection benchmarks. See, e.g., *WorldVu Satellites Limited, Radio Station Authorization*, IBFS File No. SES-LIC-20190930-01217 (granted Apr. 27, 2021) (call sign E190727).

⁷ *Amendment of Parts 2 and 25 of the Commission's Rules to Permit Operation of NGSO FSS Systems Co-Frequency with GSO and Terrestrial Systems in the Ku-Band Frequency Range*, 16 FCC Rcd. 4096, 42 (2000).

⁸ Section 25.228(j) covers operation with TDRSS and Radio Astronomy. For these experimental operations, SpaceX will not operate within radio line of sight of the listed facilities unless SpaceX has coordinated its operations.