SpaceX Responses (STA File Number: 1721-EX-ST-2022)

(1) Please provide the size of proposed 200 SpaceX phased array antenna, including fixed devices and ESIMs.

This STA application covers next-generation phased array antennas, including fixed devices and ESIMs, with dimensions not to exceed 0.586 x 0.385m.

(2) Please Provide SpaceX phased array antenna's pattern performances:

(a) Please provide the co-polarized gain (dBi) with an individual scan angle (elevation angle (°) and skew angle (°)), plus and minus from 0 to 10 degrees, 0 to 45 degrees, and 0 to 180 degrees with FCC 25.209 envelop superimposed on each measured pattern, in the azimuth and elevation planes. Please provide the on-axis gain that exceeded the FCC 25.209 on-axis gain mask. Please provide the on-axis gain that exceeded the FCC 25.209 on-axis gain mask. Please provide the off-axis gain that exceeded the FCC 25.209 off-axis gain mask.

(b) Please provide the Off-axis EIRP density envelopes (dBW/MHz) and/or (dBW/4 kHz) with an individual scan angle (elevation angle (°) and skew angle(°)) (ESD mask), plus and minus from 0 to 10 degrees, 0 to 45 degrees, and 0 to 180 degrees with FCC 25.218(f) envelop superimposed on each measured pattern, in the azimuth and elevation planes. Please provide the Off-axis EIRP density that exceeded the 25.218(f) envelop.

(c) Alternately, please provide applicant's "defined" Off-axis EIRP density envelopes (dBW/MHz) and/or (dBW/4 kHz) with an individual scan angle (elevation angle and skew angle) (ESD mask), plus and minus from 0 to 10 degrees, 0 to 45 degrees, and 0 to 180 degrees with FCC or ITU envelop superimposed on each measured pattern, in the azimuth and elevation planes:

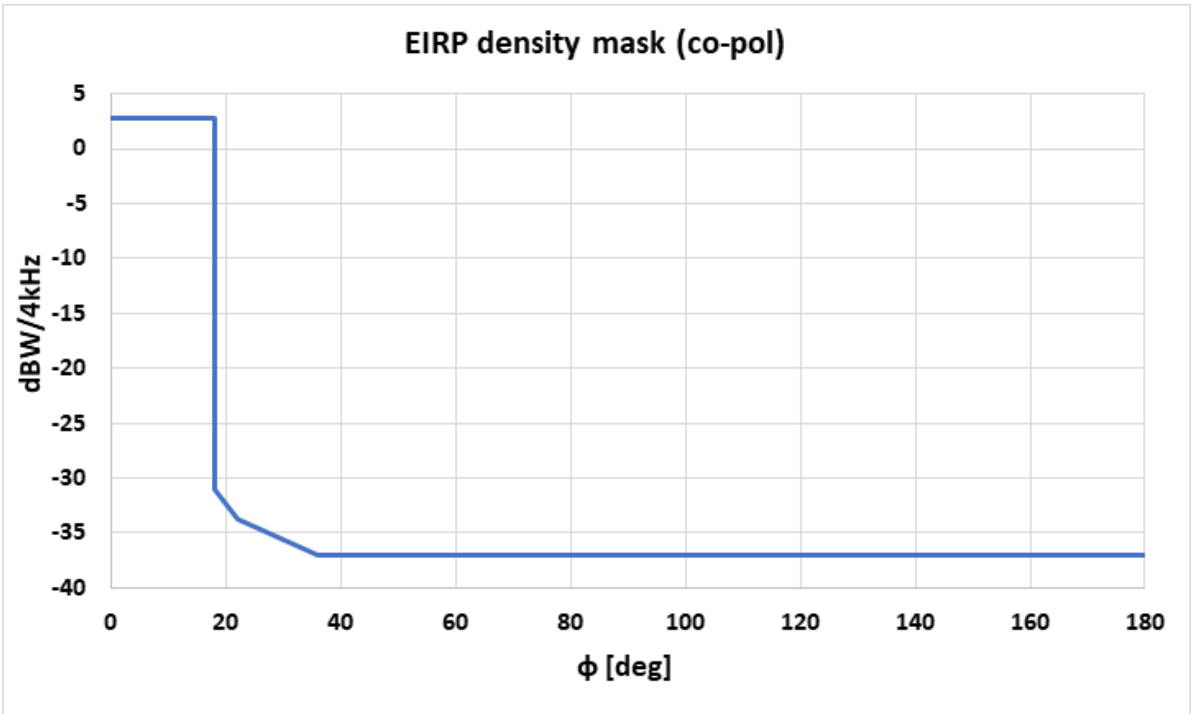
(1) For co-polarized transmissions in the plane tangent to the NGSO arc:
xx-25log(?) dBW/MHz for 2.0° = ? = 7°.
xx dBW/MHz for 7° = ? = 9.2°.
xx-25log(?) dBW/MHz for 9.2° = ? = 19.1°.
xx dBW/MHz for 19.1° < ? = 180°.

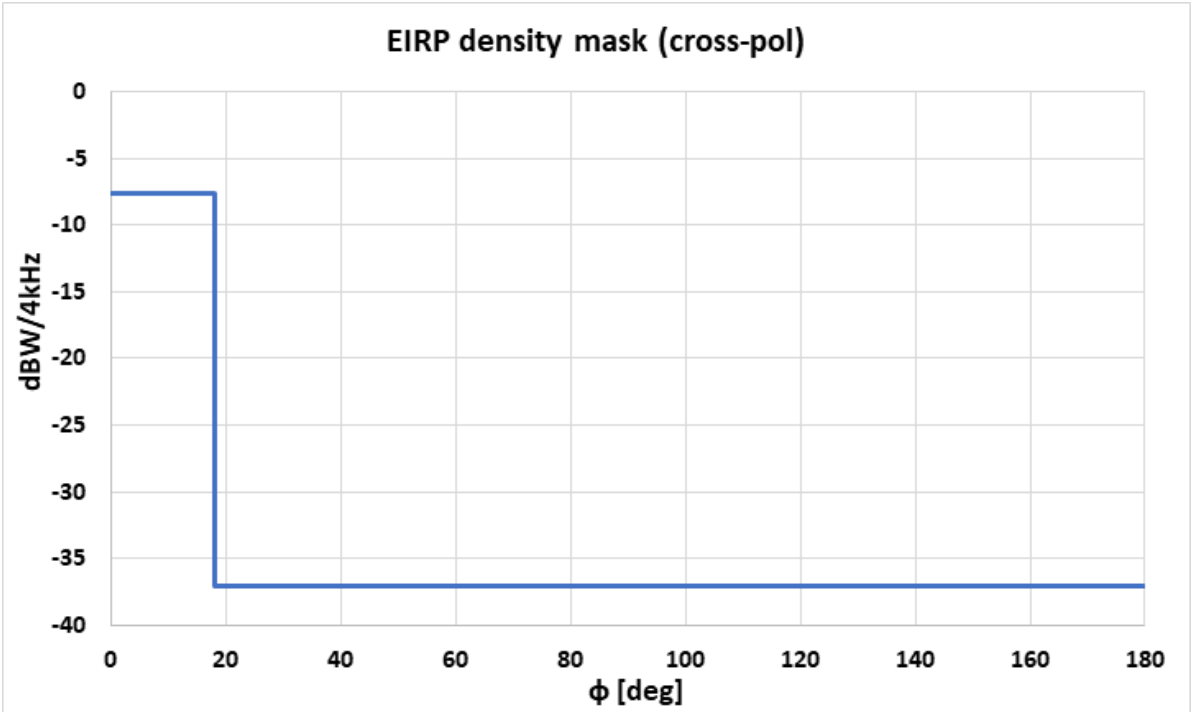
(2) For co-polarized transmissions in the plane perpendicular to the NGSO arc:
xx-25log(?) dBW/MHz for 3.5° = ? = 7°.
xx dBW/MHz for 7° < ? = 9.2°.
xx-25log(?) dBW/MHz for 9.2° < ? = 19.1°.
xx dBW/MHz for 19.1° < ? = 180°.

(3) For cross-polarized transmissions in the plane tangent to the NGSO arc and in the plane
perpendicular to the NGSO arc:
xx-25log(?) dBW/MHz for 2.0° < ? = 7.0°.

SpaceX provided EIRP density masks in its initial application. SpaceX did not depict the 25.209 envelope, because it does not apply to NGSO user terminals.

Here the EIRP masks of the initial application for reference:





(3) Please provide the input power density of an individual SpaceX phased array antenna: xxdBW/4 KHz.

Max input power density: -36.3 dBW/4kHz

(4) Please provide the elevation angle when the SpaceX phased array antenna starts to track the SpaceX's NGSO satellite in view.

25-degree min elevation

(5) In order to protect GSO satellites operating in the band, please provide the angular separation/avoidance angle (x°) between the SpaceX's 570km orbit and the GSO arc as seen from Los Angeles, LOS ANGELES,CA- NL 33-55-16; WL 118-19-41; Mountain View, SAN FRANCISCO, CA- NL 37-24-03; WL 122-03-00; Redmond, KING, WA- NL 47-41-35; WL 122-02-06; and Riverton, FREMONT, WY- NL 43-01-28; WL 108-22-50; such that as the SpaceX phased array antenna is tracking the SpaceX's NGSO satellites, it will not radiate within the specified angular separation/avoidance angle (x°) of the GSO arc.

As detailed in the Interference Protection narrative attached to the application, the SpaceX NGSO system, including the operations proposed in this STA application, protects GSO operators from harmful interference by ensuring compliance with the ITU EPFD limits provided in Article 22 and Resolution 76 of the ITU Radio Regulations across the total SpaceX system. The Commission has concluded that systems that observe these limits will be deemed not to cause harmful interference to GSO systems. These EPFD protections do not require specific avoidance angles.

See 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).

(6) Based on the technical parameters provided in the application : altitude 570km of SpaceX's NGSO satellite), the 14-14.5 GHz band, and:

> **(a) the 9900 W ERP, 42.1 dBW EIRP and emission of 60M0D7W, the result of calculation for equivalent power flux-density (EPFD) limit in the Earth-to-space direction (EPFDup) is -145.8 dBW/m2 in 40 kHz bandwidth and,**
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> **(b) the 1161.45 W ERP, 32.8 dBW EIRP (considered the 11.8% Duty Cycle) and emission of 60M0D7W, the result of calculation for equivalent power flux-density (EPFD) limit in the Earth-to-space direction (EPFDup) is -155.1 dBW/m2 in 40 kHz bandwidth; which (both (1) & (2)) exceeds the EPFDup limit of -160 dBW/m2 in 40 kHz bandwidth set-forth in Table 22-2, Section II, Article 22 of the ITU Radio Regulations. In order to meet the ITU's -160 dBW/m2 EPFDup limit, the ERP and EIRP should be reduced to 0.37W ERP and -2.2 dBW EIRP.**
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> **Alternately, the applicant may demonstrate how the operation of SpaceX phased array antenna operating in the 14-14.5 GHz band via the SpaceX 's NGSO satellite will be in compliance with the EPFDup limit of -160 dBW/m2 in 40 kHz bandwidth set-forth in Table 22-2, Section II, Article 22 of the ITU Radio Regulations.**

As detailed in the Interference Protection narrative attached to the application, the SpaceX NGSO system, including the operations proposed in this STA application, protects GSO operators from harmful interference by ensuring compliance with the ITU EPFD limits provided in Article 22 and Resolution 76 of the ITU Radio Regulations across the total SpaceX system. The ITU's EPFD calculation methodology is complex and uses specialized software to perform a time-domain simulation with respect to an entire NGSO system and cannot perform on a single-entry basis. However, the Commission has thoroughly reviewed SpaceX's EPFD compliance in the context of its NGSO system authorizations under Part 25. The

Commission has concluded that systems that observe these limits will be deemed not to cause harmful interference to GSO systems.

See 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). *See also, e.g., Space Exploration Holdings, LLC*, FCC 22-91 ¶¶ 26-40 (rel. Dec. 1, 2022) (discussing SpaceX's certification of compliance with EPFD limits for the SpaceX "Gen2" system.)