Sidus Space

LizzieSat Constellation Technical Narrative

1. Introduction

This Technical Narrative contains the information required in Section 24.114 and other relevant sections of the Federal Communications Commission ("Commission" or "FCC") Part 25 Rules that cannot be fully captured in the Schedule S and Orbital Debris Assessment Report ("ODAR"), including but not limited to the orbital configuration, facilities, operations, interference, and orbital debris mitigation compliance of the Sidus LizzieSat Constellation.

2. The Sidus LizzieSat Constellation

The initial deployment of Sidus's planned non-geostationary ("NGSO") Earth exploration satellite service ("EESS") system consists of four technically identical satellites (25.114(a)(2)), designed to have an estimated operational lifetime of five years (25.114(c)(10)), at sun-synchronous altitude of 525 km and an inclination of 97.5 degrees (the "LizzieSat Constellation," each component satellite, a "LizzieSat"). These four satellites are referred to as LizzieSat-3 (LS-3), LS-4, LS-5, and LS-6. A breakdown of the orbital parameters, plane counts, satellites (or space stations), per plane is provided in Table 1.

Table 1. Sidus LizzieSat Constellation Orbital Parameters

Plane	Satellites per Plane	Inclination	LTAN / RAAN (Estimates)	Launch Vehicle	Launch Date
1	2 (LS-3 and LS-4)	97.5°	13:00 + 60 min	Transporter 10	NET February 2024
2	2 (LS-5 and LS-6)	97.5°	13:00 + 60 min	Transporter 11	NET June 2024

A complete showing of additional parameters as required in 25.114(c)(6)(i)-(x) is provided in the Schedule S.

2.1 Space Segment

Sidus will operate its satellites from its Mission Control Center ("MCC") in Cape Canaveral, Florida. Sidus also designs, develops, and manufactures each spacecraft at the same state-of-the-art facility, verifying full LizzieSat and payload functionality prior to shipping the integrated spacecraft to an acceptance test facility in Orlando, Florida.

Figure 1 provides a rendering of a single LizzieSat, with a mass of up to 100 kg, of which 65 kg is the standardized bus and 35 kg is available for Sidus or third-party provided payloads. The LizzieSat bus includes eight deployable solar arrays, which are in a stowed configuration during launch. The attitude control system has a mean accuracy of 0.01 degrees using a combination of four reaction wheels (one backup) and three magnetorquers. There is no propulsion onboard.

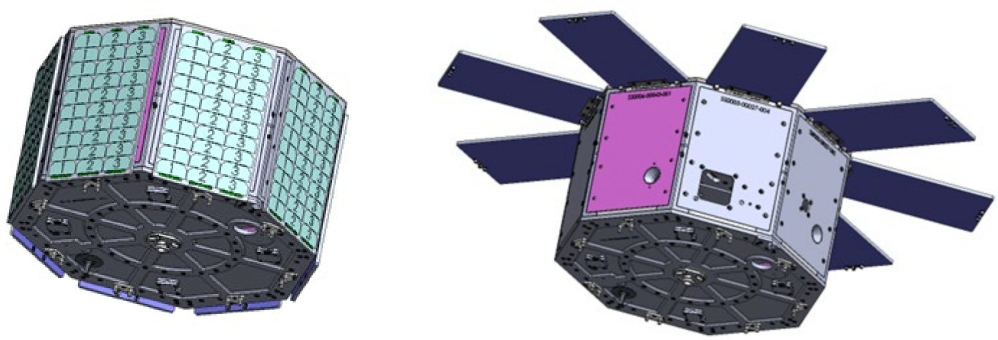

Figure 1. Sidus LizzieSat Satellite

The communications system utilizes three communication channels: two in S-band for TT&C, and one in X-band for mission payload and sensor data downlink. The S-band IQ Spacecom transceiver is TRL-9 spaceflight heritage and is connected to two S-band antennas, one of which the solar panels cover in the stowed configuration, while the other is visible. The primary Anywaves S-band antenna is located below the +X/+Y solar panel for launch and separation, becoming available for operations once the satellite boots up, the solar arrays are deployed, and the spacecraft has slewed to the Nadir pointing communications attitude. The backup Flexitech S-band turnstile antenna will be used during the commissioning phase when the vehicle operates without deployed solar arrays. After solar array deployment, the Anywaves S-band antenna will serve as the primary antenna for the duration of the mission, and the Flexitech S-band turnstile will only be utilized in the event the primary antenna fails or malfunctions.

The X-band transmitter on each LizzieSat is the flight heritage EnduroSat 4 Element Patch antenna, operating across the full 8025 - 8400 MHz frequency range. All LizzieSats are 3-axis stabilized and achieve beam steering via body steering of the bus.

The LizzieSat satellites will each have five common third-party payloads. LS-3, LS-5, and LS-6 are identical. LS-4 includes an additional imager. Specifically, all four LizzieSats will include:[1]

- Raptor Photonics Owl 1280 Visible Short Wave Infra-Red (VIS-SWIR) imager. Resolution is 1280 x 1024 pixels with 10 micrometer capability. Each Owl includes a Chromar 845mm / F8.8 Catadioptric VIS SWIR Lens. The combination imager and lens provides 5.92 m Ground Sampling Distance ("GSD") from 525 km altitude.

- Raptor Photonics Hawk 1920 Complementary Metal Oxide Semiconductor (CMOS) High Definition (HD) imager. Resolution is 1920 x 1080 pixels with 4.5 micrometer capability. Each Hawk includes a Chromar 845 mm / F8.8 Catadioptric VIS SWIR Lens. The combination imager and lens provides 2.66m GSD from 525 km altitude.

- Satlab Polaris Autonomous Information System ("AIS") with a passive fixed mount VHF receiver to collect marine data.

[1] Sidus previously received a NOAA license for the LS-2 to LS-8 satellites prior to filing the LS-2 experimental license. *See* ELS File No. 0545-EX-CN-2023. Sidus is in the process of submitting a new authorization request for LS-3 to LS-6 to reflect the payloads described in the instant Application.

- ExoSpace FeatherEdge Data Processing Unit ("DPU"), which inputs data from the hyperspectral imager and AIS sensors to process data in space;[2] and
- SkyServe Edge-Computing Platform, inputs data from the hyperspectral imagers to process data in space.[3]

LS-4 will also host a HEO Robotics "Holmes" telescopic camera for non-Earth imaging ("NEI"). The Holmes imager is specifically designed for NEI space-to-space imaging and will capture images of spacecraft as the LizzieSat moves through its orbit.[4]

2.2 Ground Segment

Sidus will conduct its mission operations–sending commands from the Sidus MCC to the LizzieSat Constellation—through a network of ground stations that will initially consist of commercial facilities operated by KSAT and ATLAS. These commercial facility providers are responsible for all manufacturing and operations, including approvals, of the ground station network. Sidus may expand its ground station network over the course of the operational lifetime of the LizzieSat satellites to include additional commercial stations either within or outside the United States and will seek to modify its authorization as conditions arise.

Table 2 provides the locations of the six KSAT and four ATLAS earth stations, one of which is in the United States (shown in bold). All S-band downlinks will be operated outside of the United States. All earth stations uplink in S-band and downlink in both S- and X-band, except for the Barrow, Alaska site, which uplinks in S-band and downlinks in X-band only.

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[2] The payload does not transmit. All data from the payload is transmitted by way of the X-band data downlink on the LizzieSat bus.
[3] The payload does not transmit. All data from the payload is transmitted by way of the X-band data downlink on the LizzieSat bus.
[4] In its current configuration onboard LizzieSat, the imager is not intended for, nor will it perform, proximity operations. As noted above, Sidus has applied for NOAA authorization for all of the imagers and sensors on the spacecraft, including for the NEI operations of the Holmes imager. The authorization is pending.

Table 2. S-/X-band Earth Stations Baselined for Sidus Operation

Location	Latitude	Longitude	Provider
Athens, Greece	37.85° N	22.62° E	KSAT
Awarua, New Zealand*	46.53° S	168.38° E	KSAT
Hartebeesthoek, South Africa*	25.89° S	27.71° E	KSAT
Puertollano, Spain*	38.67° N	4.16° W	KSAT
Punta Arenas, Chile*	52.94° S	70.87° W	KSAT
St. Martin, Mauritius	20.50° S	57.45° E	KSAT
Barrow, Alaska USA	**71.28° N**	**156.81° W**	**ATLAS**
Dundee, Scotland	56.41° N	3.19° W	ATLAS
Mingenew, Australia	29.01° S	115.34° E	ATLAS
Dubai, United Arab Emirates	24.94° N	55.35° E	ATLAS

The antennas at each site are 3.7 m or 5.0 m in diameter and maintain elevation angles above 10 degrees, conforming with 25.205(a) of the Commission's rules. The KSAT earth stations have a 3.7 m reflector with an EIRP of 44.8 dBW in the 2025 - 2110 MHz band, a G/T of 12 dB/K in the 2200 - 2290 MHz band and a G/T of 26.2 dB/K in the 8025 - 8400 MHz. The ATLAS earth stations have a 3.7 m or 5.0 m reflector with an EIRP of 48 - 55 dBW in 2025 - 2110 MHz, a G/T of 12.8 - 14 dB/K in the 2200 - 2290 MHz band and a G/T of 25.4 - 29.5 dB/K in the 8025 - 8400 MHz band, depending on the ground station.

Figure 2 provides a map of the ten earth stations across the world with KSAT shown in black and ATLAS shown in yellow.

Figure 2. Map of KSAT and ATLAS Earth Stations for Sidus Operations

Sidus has initiated coordination efforts with Federal operators in its requested bands and will operate in accordance with the terms of any agreements.[5]

3. Facilities, Operations, and Services

This section defines the facilities, operations, services and how the uplink frequencies are connected to the downlink frequencies for the LizzieSat Constellation in accordance with 25.114(d)(1) of the Commission's Rules.

3.1 Facilities

In addition to design and manufacturing services, Sidus will also operate all telecommand and telemetry through from its MCC located in Merritt Island, FL, which will route the

[5] Sidus agrees to be bound by the same pre-coordination agreement with NASA as in its two experimental authorizations: the LizzieSat satellites will not transmit to the identified sites (*) in Table 2 using its primary S-band downlink at 2201.25 MHz, but will instead transmit on its backup transmission frequencies at 2262.25 MHz or 2283.25MHz

commands through the commercial ground station networks to the LizzieSat Constellation. No transmissions flow directly from the MCC to the LizzieSats. In the event the X-band transmitter is inoperable (e.g. Solar panel blockage), the S-band downlink may also be used for payload data downlink.

All LizzieSat transmissions are encrypted via AES-CTR-256 encryption with a table of 128 pre-shared keys. Each packet uses truncated SHA256-HMAC with a pre-shared key. All of these operations will be properly secured and maintained against unauthorized access, ensuring the security of all satellite commands, as required in 25.271 of the Commission's rules.

3.2 Operations

Sidus has registered with the U.S. Space Force's 18th Space Defense Squadron ("SDS") and will share information regarding initial spacecraft deployment, ephemeris, and planned maneuver information. Each LizzieSat will utilize a unique telemetry marker at deployment to assure it can be identified. Sidus will maintain a complete and accurate set of current and planned radiofrequency transmissions for its satellites and will provide any necessary technical information to other space station satellites in order to identify and promptly resolve any potential causes of radio frequency interference between systems. The 18th SDS will be able to contact the Sidus satellite operations team 24 hours a day, seven days per week to ensure that Sidus can take immediate action to coordinate collision avoidance measures.

3.2.1 Launch

Sidus plans to launch the four LizzieSat spacecraft in pairs on the successive SpaceX Transporter 10 and Transporter 11 missions, currently scheduled for launch NET February and June 2024, respectively, out of Vandenberg Air Force Base, California.

3.2.2 In-orbit Operations

The spacecraft will not include propulsion, and therefore the satellites will not maintain orbital parameters including inclination angle, apogee, perigee, and right ascension of the ascending node to any specified degree of accuracy. Sidus will monitor the location of satellites passively utilizing two-line elements ("TLEs") and the GPS module and will also propagate trajectories of all spacecraft to enhance the quality of conjunction predictions with other space stations. Each satellite is larger than 10 cm in its smallest dimension and is assumed to be trackable.

After separation from the launch vehicle, each spacecraft separates at 0.3 m/sec and will begin a flight computer bootup sequence approximately two minutes after separation. Within 10 minutes after separation, the satellite autonomously initiates detumble to get rates below 0.06 deg/sec using a combination of three magnetic-torque rods and four reaction wheels. The magnetic-torque rods initially damp rates <0.3 deg/sec, then LizzieSat transitions to reaction wheels to complete the detumble sequence (attitude rates <0.06 deg/sec). Once rates are damped, the reaction wheels take over as prime for attitude changes and precision pointing. Attitude modes are managed onboard using four reaction wheels, two star trackers, two inertial measurement units, six sun sensors, a magnetometer, and three magnetic-torque rods. When rates are <0.06 deg/sec, the LizzieSat solar panels are deployed, and the spacecraft is re-oriented to Sun Track attitude to charge the onboard batteries.

S-band telecommand transmissions are received by the spacecraft through a prime or backup antenna with near-omni directional patterns during orbit operations over one of the sixteen KSAT communications passes, or thirteen ATLAS communications passes planned per day. If the spacecraft is transitioned into safe mode when not over a ground site, the Sidus MCC will execute emergency procedures immediately after Acquisition of Signal to ensure spacecraft health and safety and will work toward return to nominal operations.

As previously mentioned, Sidus will update orbital information with the 18th SDS, and upon receipt of a space situational conjunction warning, review and assess collision risk, and take all possible steps to mitigate collision risks, if necessary. Additionally, in compliance with 25.207, each LizzieSat is capable of ceasing radio emissions via ground command to ensure definite cessation of emissions.

3.2.3 Frequency Plan

To explain how uplink frequencies are connected to downlink frequencies (25.114(d)(1)), Sidus will uplink commands and downlink telemetry in S-band, and downlink mission and payload data in X-band, with S-band as backup. In Barrow, Alaska, only X-band frequencies will be used for downlink.

Table 3 provides the specific center frequencies and frequency range of each requested channel.

Table 3. Summary of Center Frequencies and Ranges

	Center Frequency (MHz)	**Frequency Range (MHz)**
S-band Uplink (700 kHz)		
Primary	2025.35	2025.0 - 2025.7
1st Backup	2027.65	2027.3 - 2028.0
2nd Backup	2070.85	2070.5 - 2071.2
S-band Downlink (2.5 MHz)		
Primary	2201.25[6]	2200.0 - 2202.5
1st Backup	2262.25	2261.0 - 2263.5
2nd Backup	2283.25	2282.0 - 2284.5
X-band Downlink (42 MHz)		
Primary	8046	8025 - 8067
1st Backup	8379	8358 - 8400

[6] The primary S-band downlink channel at 2201.25 MHz will not be used over ground sites used by NASA's Cubesat Proximity Operations Demo ("CPOD") satellites (Punta Arenas, Chile; Awarua, New Zealand; Hartebeesthoek, South Africa; and Puertollano, Spain).

As required in 25.114(c)(7) and 25.114(c)(4)(i), Table 4 provides the frequency bands, channel bandwidths, and polarizations of the LizzieSat Constellation. The channel center frequencies are provided in the Schedule S.

Table 4. Frequency and Channel Information (25.114)(c)(7))

	S-band		**X-band**
Type of Service	Command (Earth-to-space)	Telemetry (space-to-Earth)	Payload Data (space-to-Earth)
Frequency Bands (MHz)	2025.0-2025.7 2027.3-2028.0 2070.5-2071.2	2200.0-2202.5 2261.0-2263.5 2282.0-2284.5	8025-8067 8358-8400
Channel Bandwidth	700 kHz (700KG1D)	2.5 MHz (2M50G1D)	42 MHz (42M0G1D)
Polarization	RHCP		RHCP
Modulation	OQPSK	BPSK/OQPSK	QPSK 8-PSK, 16-APSK, 32-APSK
Coverage	Global	Global (Non-U.S.)	Global
Service Class	EESS	EESS	EESS
Data Rate	256 kbps	2048 kbps	150 Mbps

In accordance with 25.202(g)(2), Sidus will utilize the minimum bandwidth necessary to meet its mission goals, to ensure overall efficient use of spectrum resources and to minimize interference into other satellite networks. Part 25.202(g)(1) of the Commission's rules stipulates that TT&C signals may be transmitted at frequencies other than the band edge if the transmissions cause no greater interference and require no greater protection than the communications traffic on the satellite network. Sidus affirms that its TT&C signals will not cause greater interference and will not require greater protection than the communications traffic on the satellite network.

3.2.4 End-of-Life

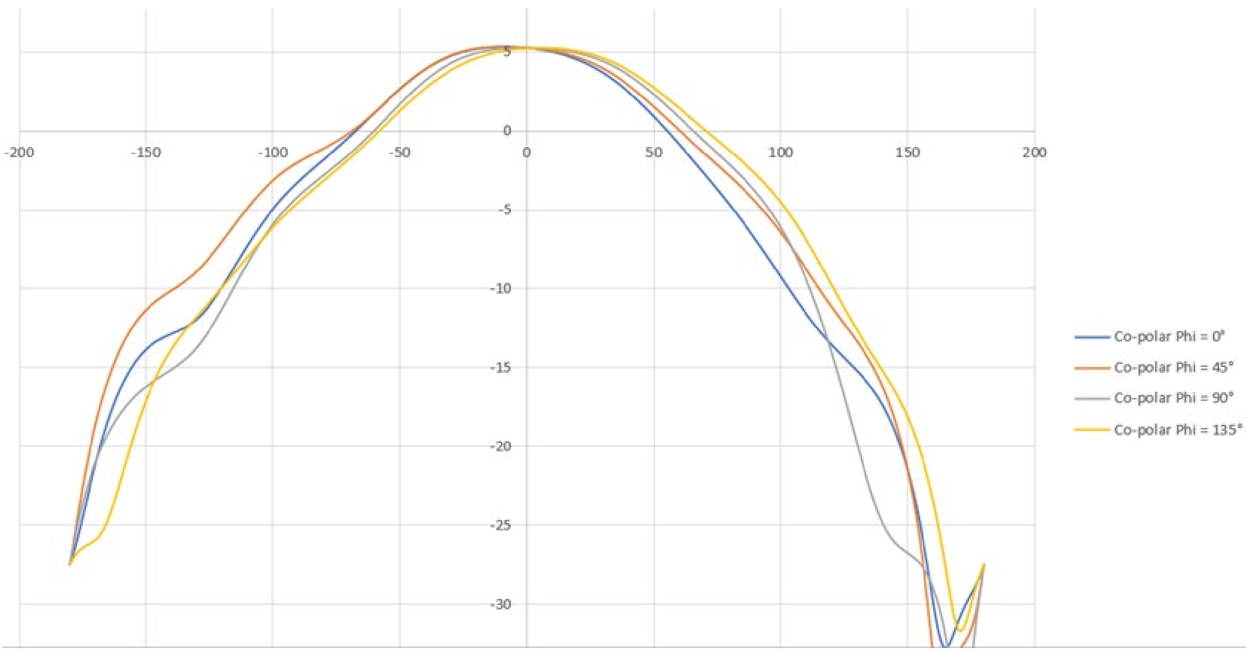
In accordance with 25.283, after the LizzieSat spacecraft have completed payload operations, the spacecraft will be decommissioned in a safe state, batteries will be discharged, and the vehicle will deorbit passively (25.114(d)(14)(ii)). At end of life, planned disposal will occur via natural orbital decay using differential drag (*i.e.*, placing the satellite in a maximum drag orientation) (25.114(d)(14)(vii)). The time to passively deorbit following completion of mission execution is under five years and therefore compliant with the rules adopted in the *2022 Orbital Debris Mitigation Order*.[7]

During orbital decay, the spacecraft will pass through the orbital altitude of the ISS. Sidus will continue to provide updated ephemeris data to 18th SDS and any other operators involved in a conjunction warning.

[7] *See Mitigation of Orbital Debris in the New Space Age*, Second Report and Order, IB Dockets 18-313 & 22-271, FCC 22-74 (2022). In the unlikely event a LizzieSat is deployed to 545 km and arrives dead on arrival, Sidus will seek appropriate waivers pursuant to the *2022 Orbital Debris Mitigation Order*'s case-by-case treatment.

4. Space Station Antenna Gain Contours

Antenna patterns for the S-band patch antenna receive (uplink) and transmit (downlink) are provided in Figure 3(a, b).

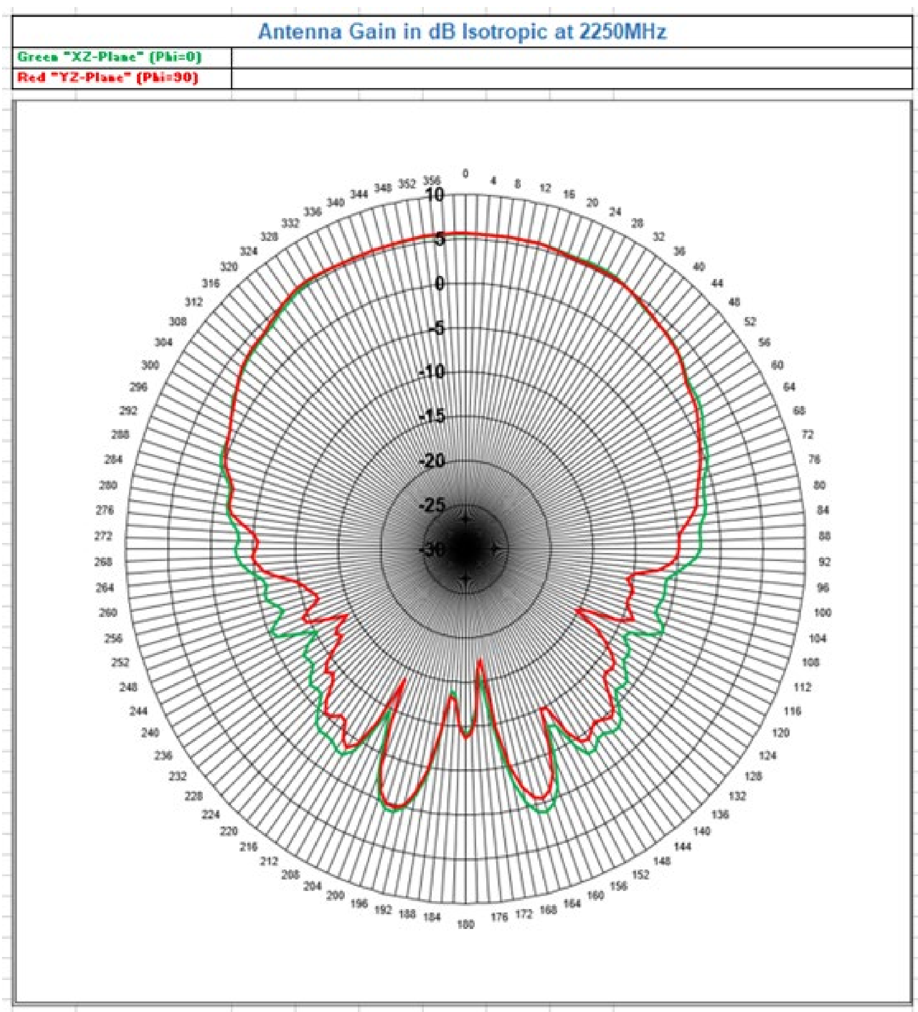


(a) S-band Uplink TT&C - Rx Antenna Pattern (Gain (dBic) vs. Angle (2025 MHz)

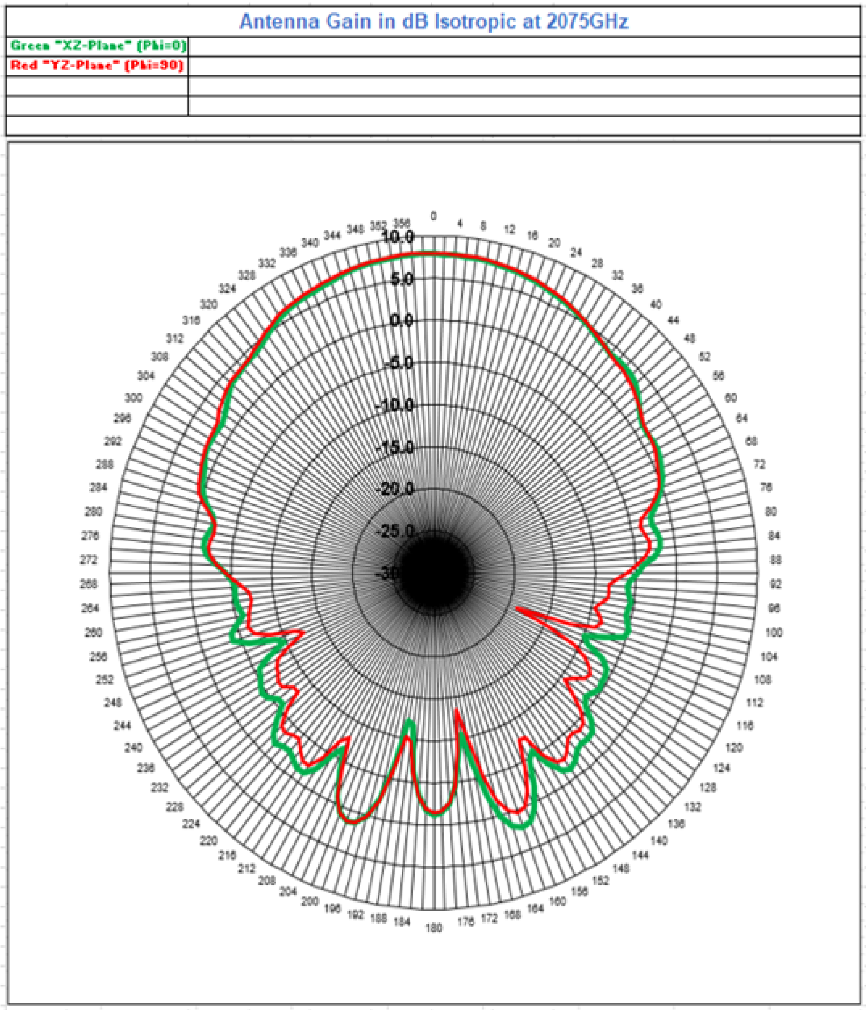
(b) S-band Downlink - Tx Antenna Pattern (Gain (dBic) vs. Angle (2200 MHz)
Figure 3(a, b): S-band TT&C Antenna Gain Pattern (a) Receive and (b) Transmit

Figure 3(b) is provided on an illustrative basis. As stated above, Sidus will not downlink in the S-band to earth stations in the United States.

Similarly, Figure 4(a, b) provides two antenna gain patterns for the Flexitech Turnstile (secondary) S-band downlink and uplink transmissions, with phi of 0 and 30 degrees.



(a) S-band TT&C – Tx Antenna Pattern (Gain (dBic) vs. Angle (2250 MHz)



(b) S-band TT&C - Rx Antenna Pattern (Gain (dBic) vs. Angle
Figure 4(a, b): Flexitech Turnstile S-band Antenna Gain Pattern (a) Transmit and (b) Receive

Figure 5 provides the antenna gain patterns for the EnduroSat X-band downlink transmissions.

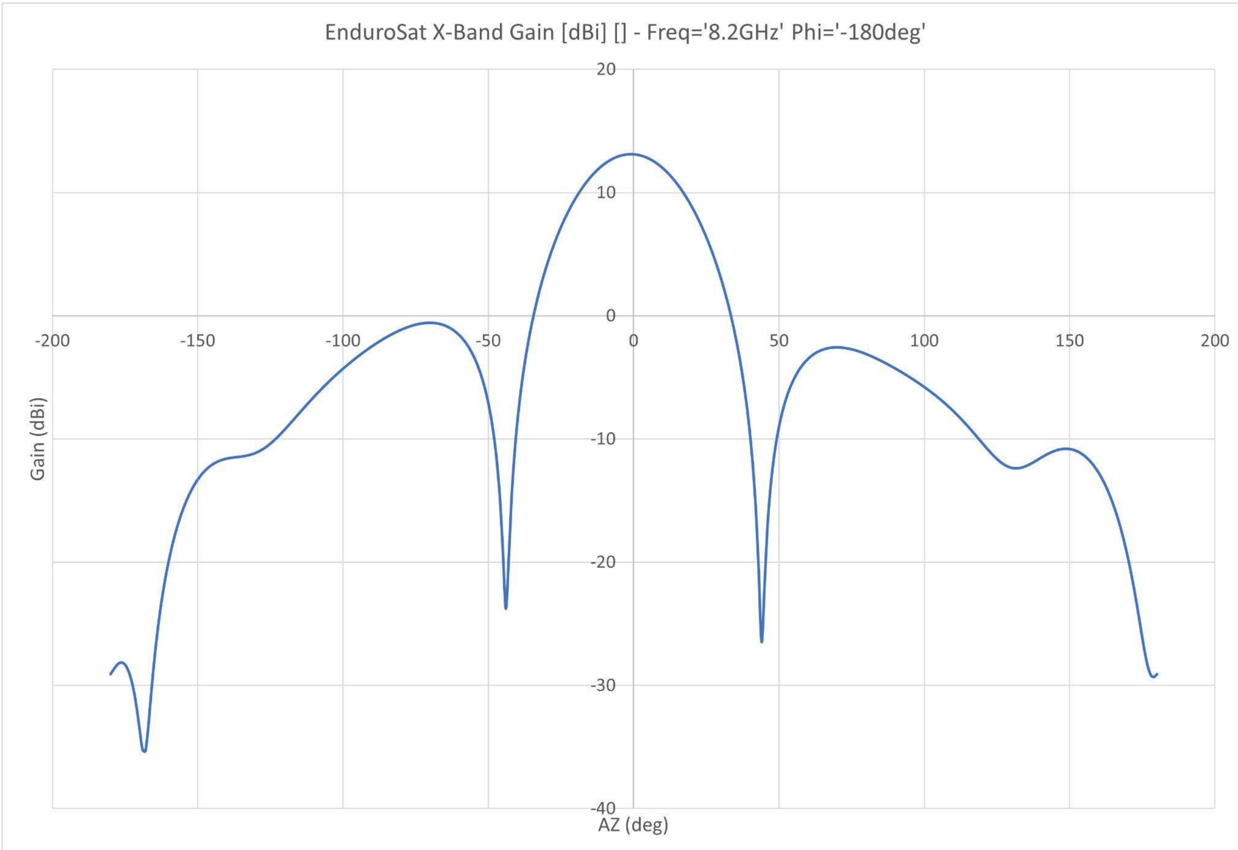
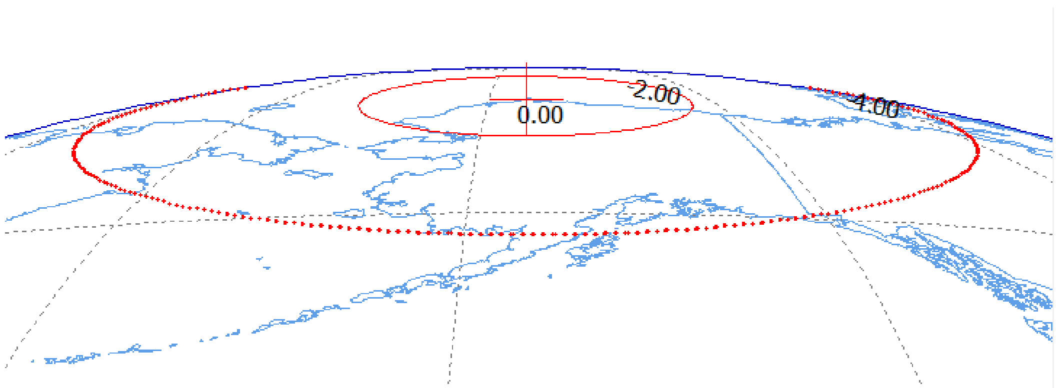


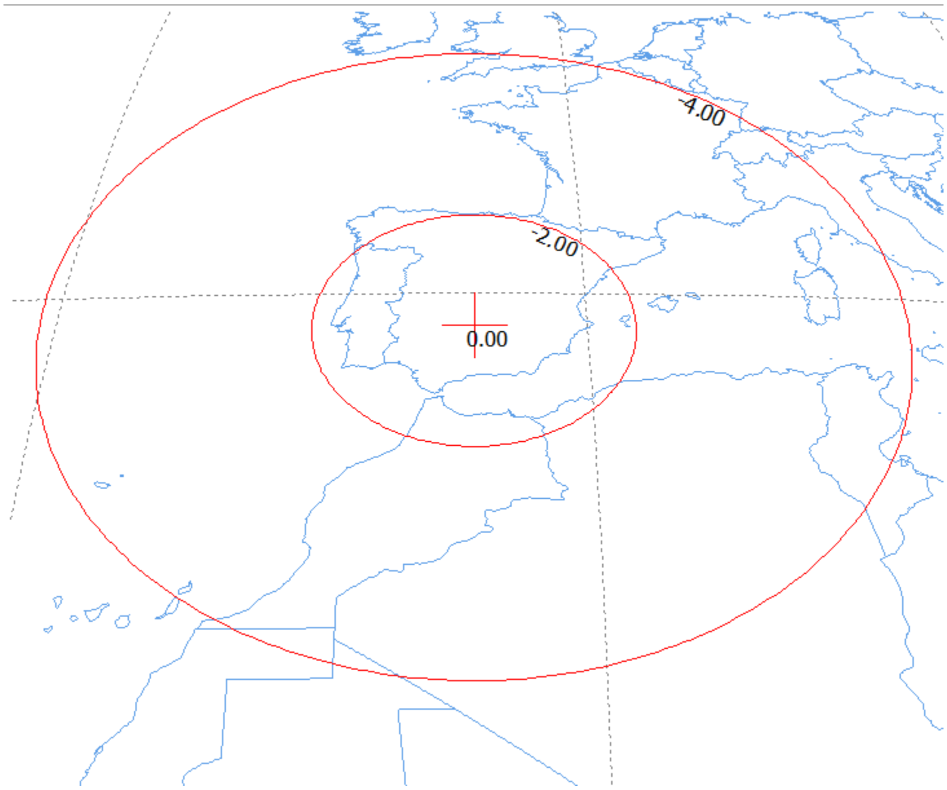
Figure 5: X-band Downlink Mission Data - Antenna Pattern at 8.2 GHz and Phi = 180 degrees

As the Commission requires in 25.114(c)(4)(vi)(B), Sidus herein provides the predicted antenna gain contours for each unique orbital plane for each transmit and receive beam. Contours are depicted on an area map with the beam shown on the surface of the Earth with the space stations' peak antenna gain pointed at nadir to a latitude and longitude within the proposed service area. Furthermore, each contour is shown at 2 dB intervals down to either 4 dB or 6 dB below the peak gain. While the regulation provides for showings at intervals of 2 dB down to 10 dB below the peak gain and at 5 dB intervals between 10 - 20 dB below the peak gain, the nature of the antenna, and orbital altitude of the spacecraft limit the visibility of the contours in the schematics.

Data for the gain contours are also embedded in the Schedule S in the form of GXT files. S-band receive gain contours are provided in Figures 6(a, b, c, d) for the patch antenna over (a) Alaska (525 km), (b) Spain (525 km), (c) Alaska (300 km), and (d) Spain (300 km). Figures 6 (c, d) are included at 300 km to reflect beam projections from the lowest planned operational orbit altitude.

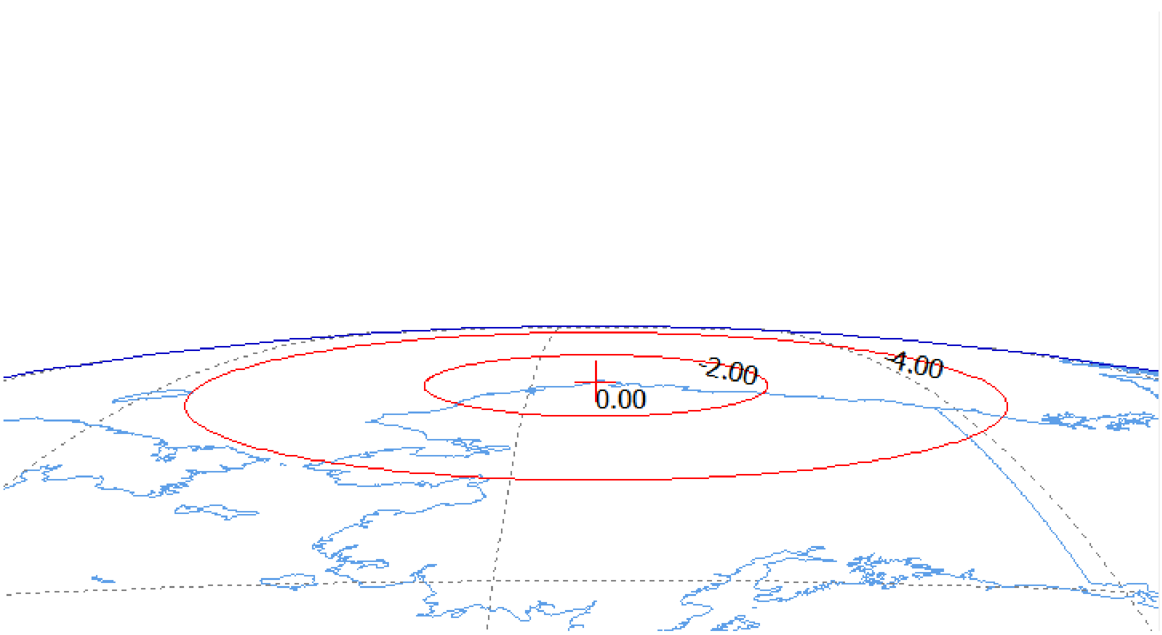


(a)

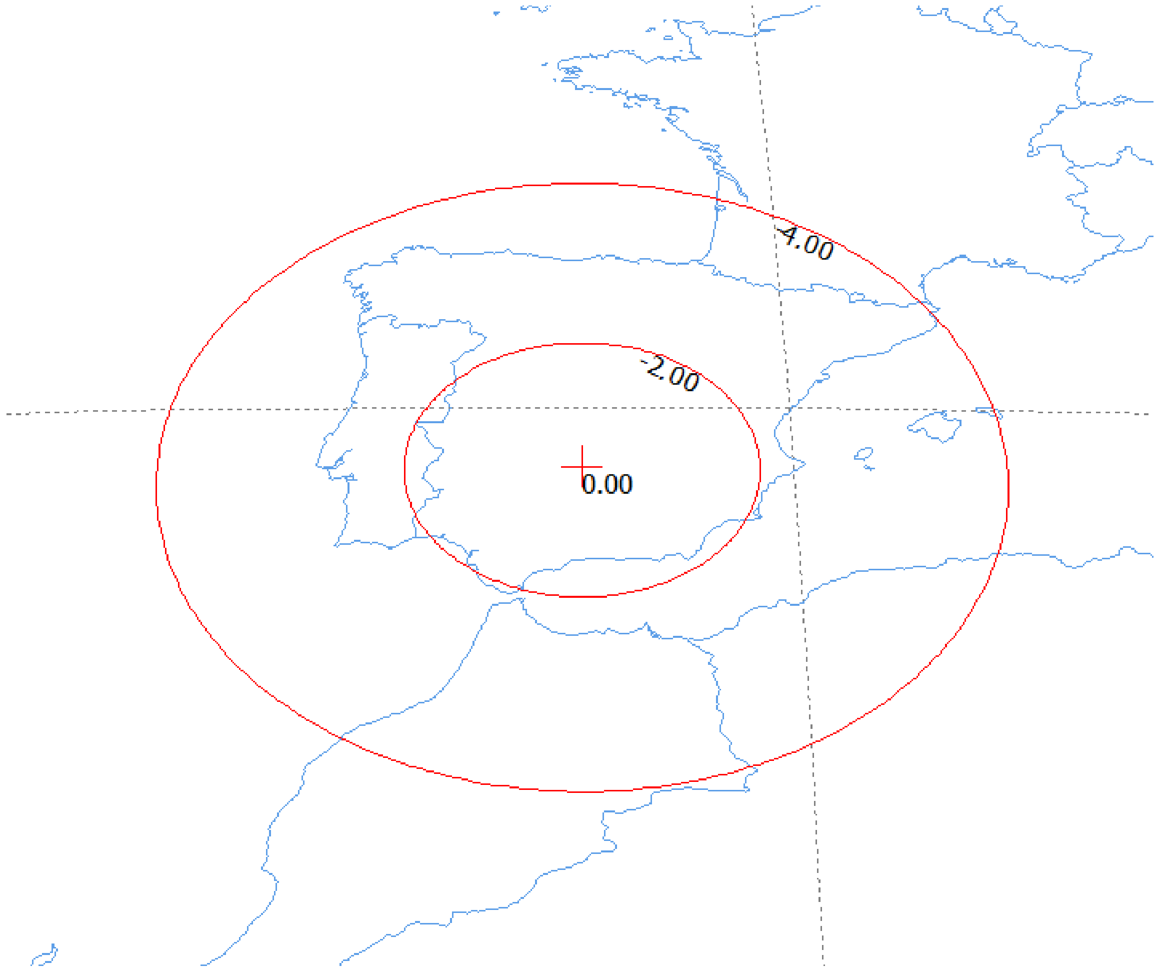


(b)

Figure 6(a, b). S-band receive uplink gain contours for the Patch Antenna over (a) Alaska and (b) Spain (525 km)



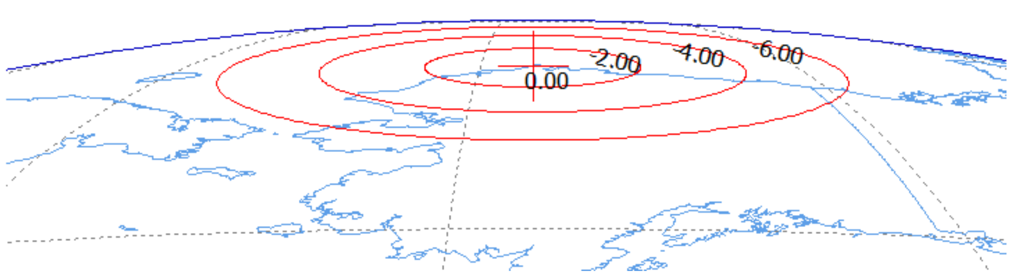
(c)



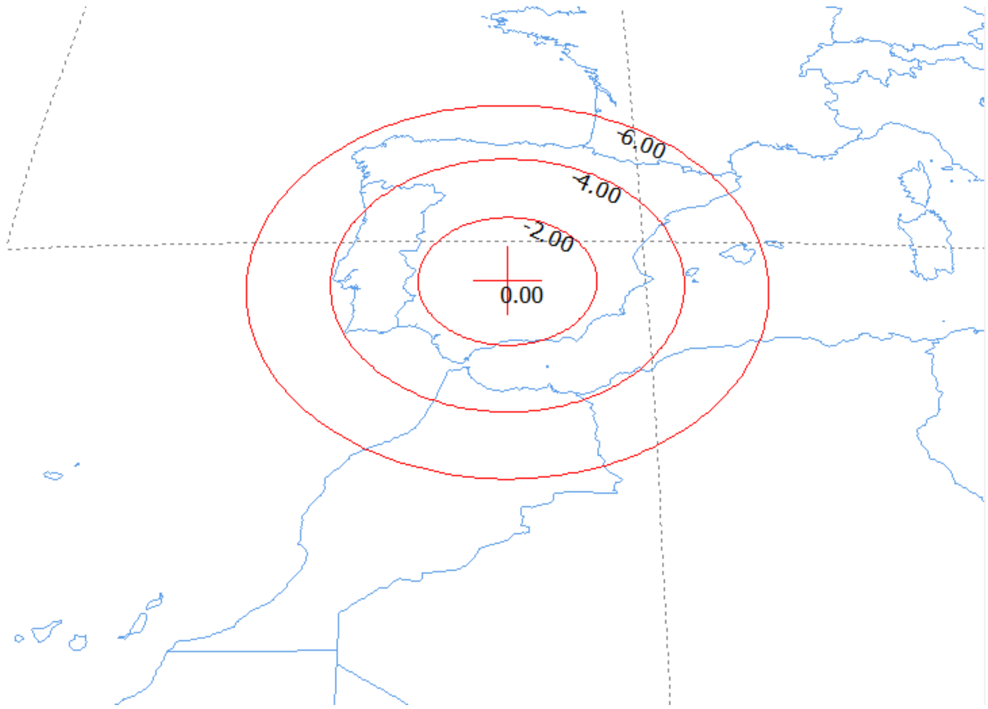
(d)

Figure 6(c, d). S-band receive uplink gain contours for the Patch Antenna over (a) Alaska and (b) Spain (300 km)

S-band receive gain contours are provided in Figures 7(a,b,c,d) for the secondary turnstile antenna over (a) Alaska (525 km), (b) Spain (525 km), (c) Alaska (300 km), and (d) Spain (300 km).

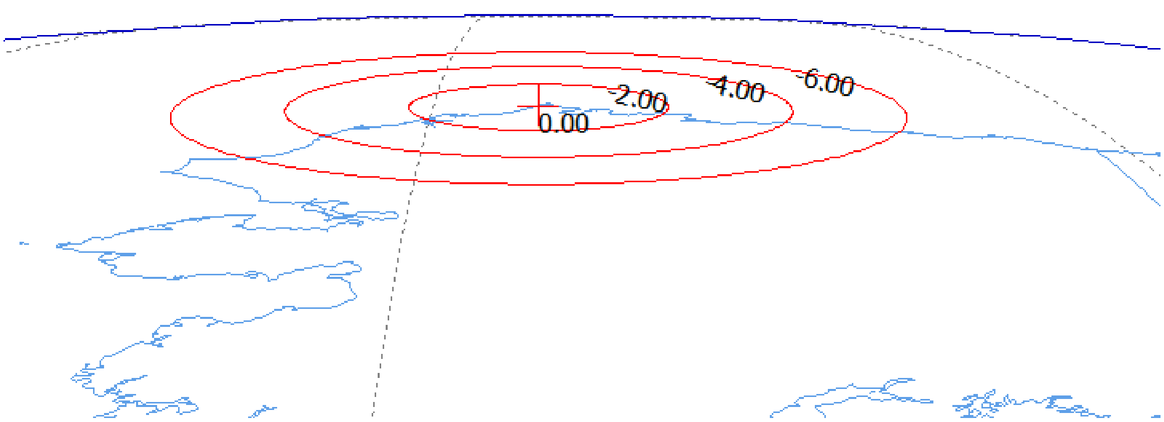


(a)

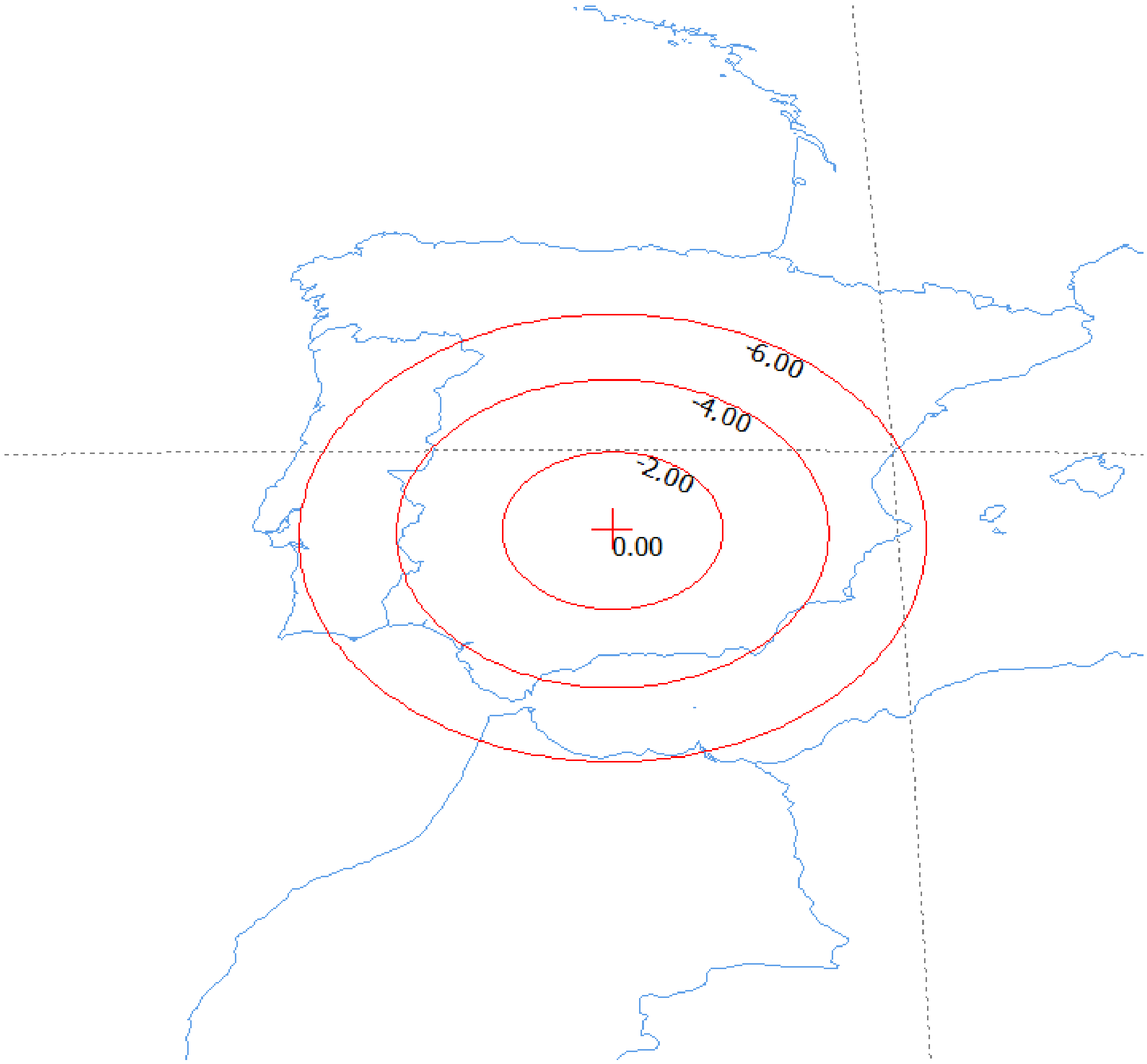


(b)

Figure 7(a, b). S-band receive uplink gain contours for the Secondary Turnstile Antenna over (a) Alaska and (b) Spain (525 km)



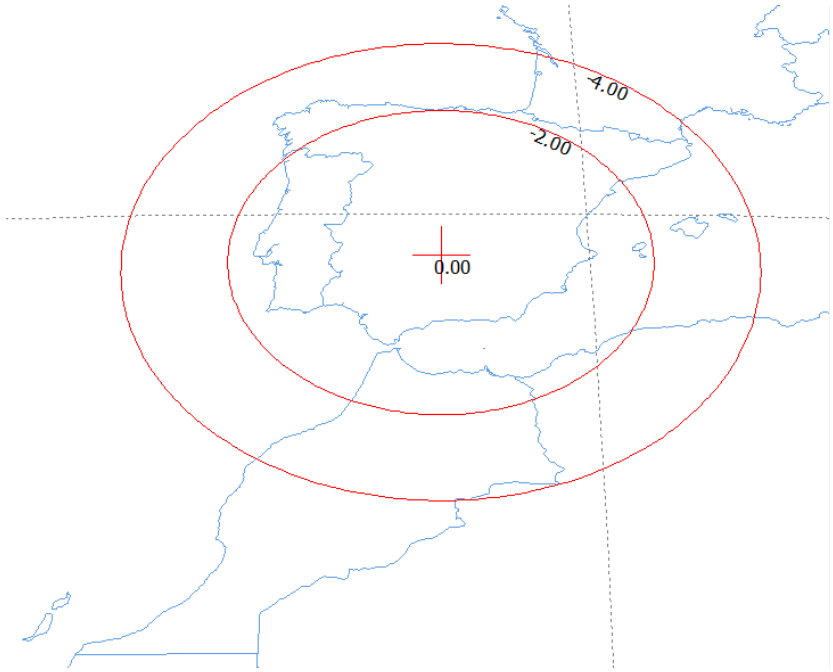
(c)



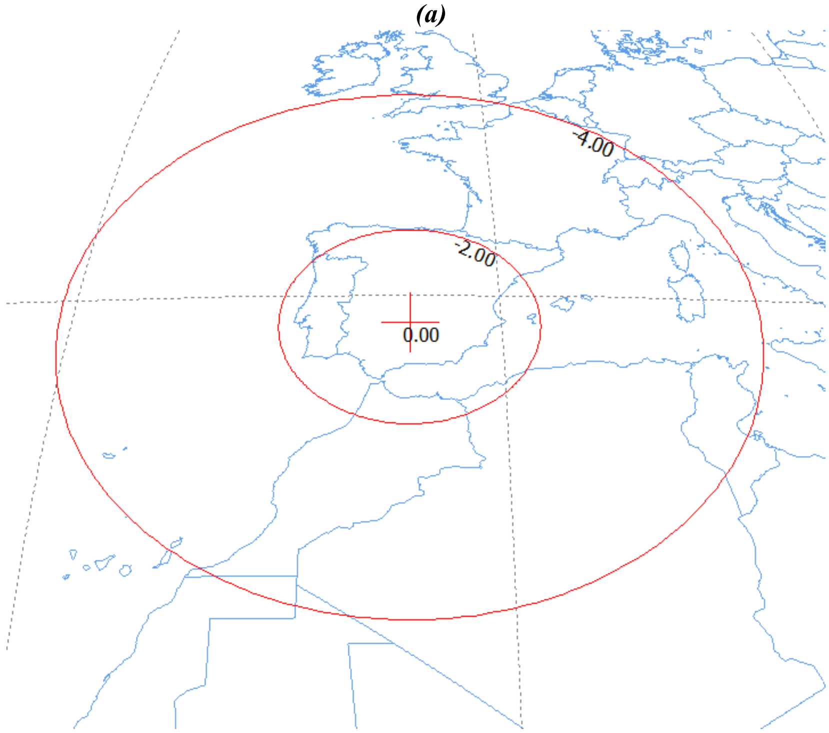
(d)

Figure 7(c, d). S-band receive uplink gain contours for the Secondary Turnstile Antenna over (a) Alaska and (b) Spain (300 km)

S-band transmit gain contours are provided in Figure 8(a, b, c, d) over Spain. A location outside of the United States was selected to reiterate that S-band downlink will not occur within the United States.

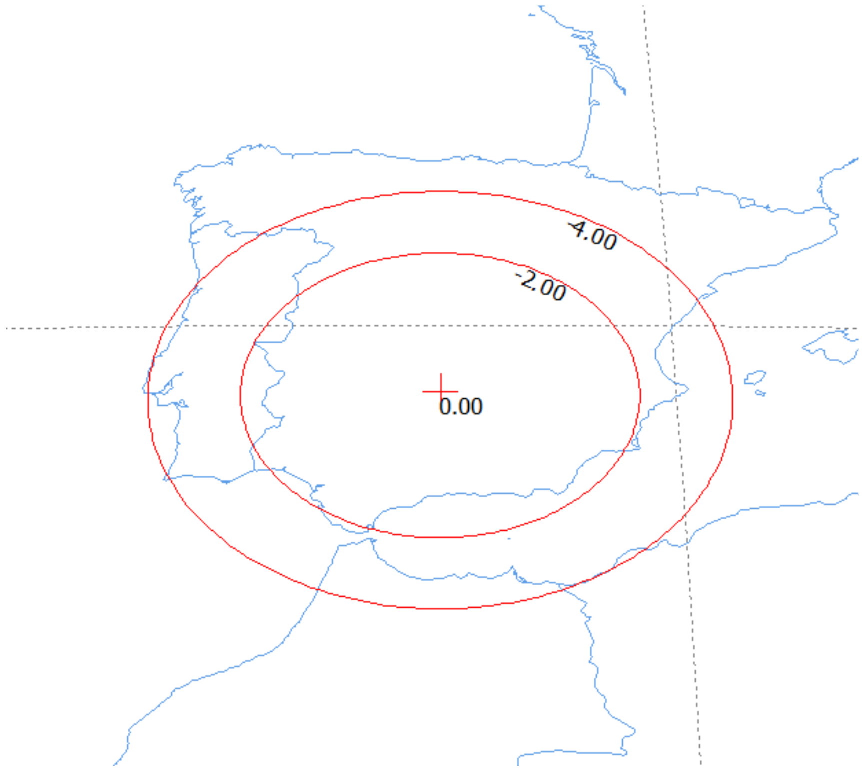


(a)

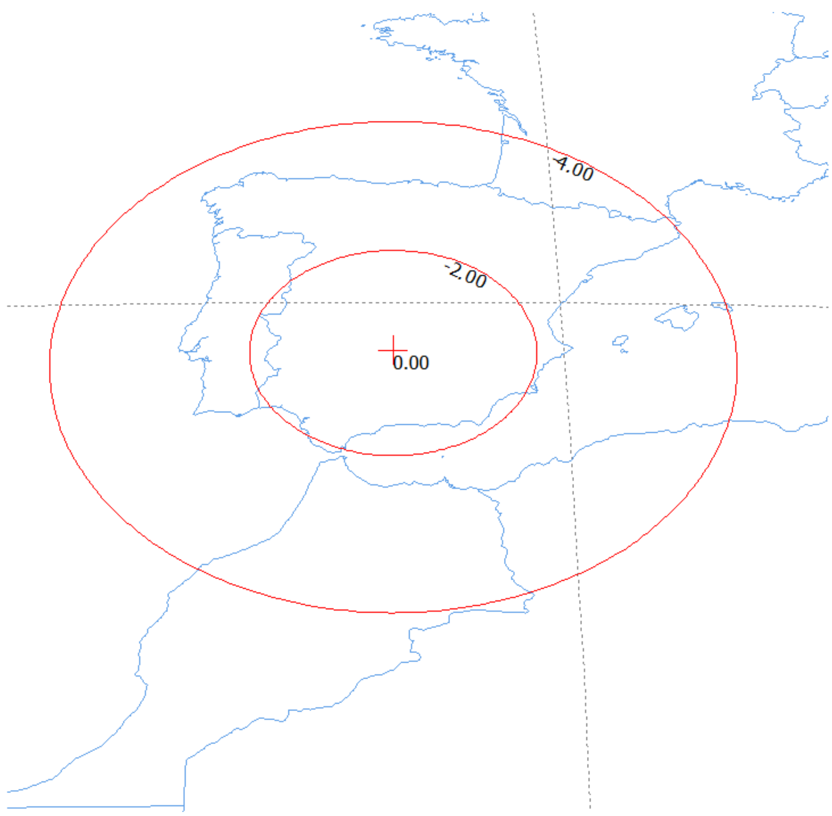


(b)

Figure 8(a, b). S-band transmit downlink gain contours for the (a) Patch and (b) Secondary Turnstile Antenna over Spain (525 km)



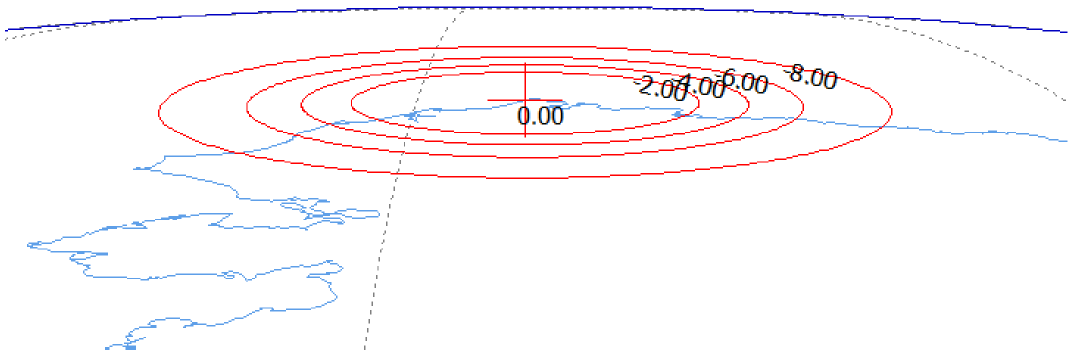
(c)



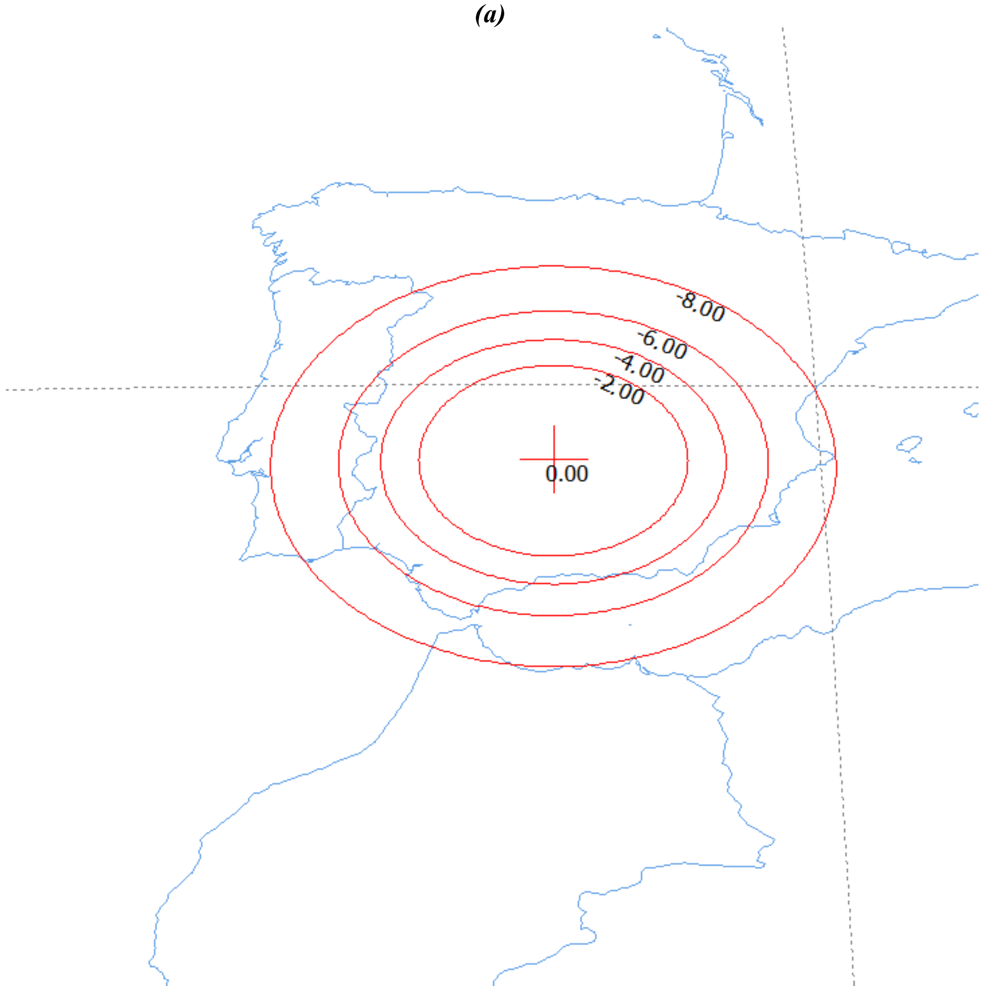
(d)

Figure 8(c, d). S-band transmit downlink gain contours for the (a) Patch and (b) Secondary Turnstile Antenna over Spain (300 km)

X-band transmit gain contours are provided in Figure 9(a, b, c, d) over (a) Alaska (525 km), (b) Spain (525 km), (c) Alaska (300 km), and (d) Spain (300 km).

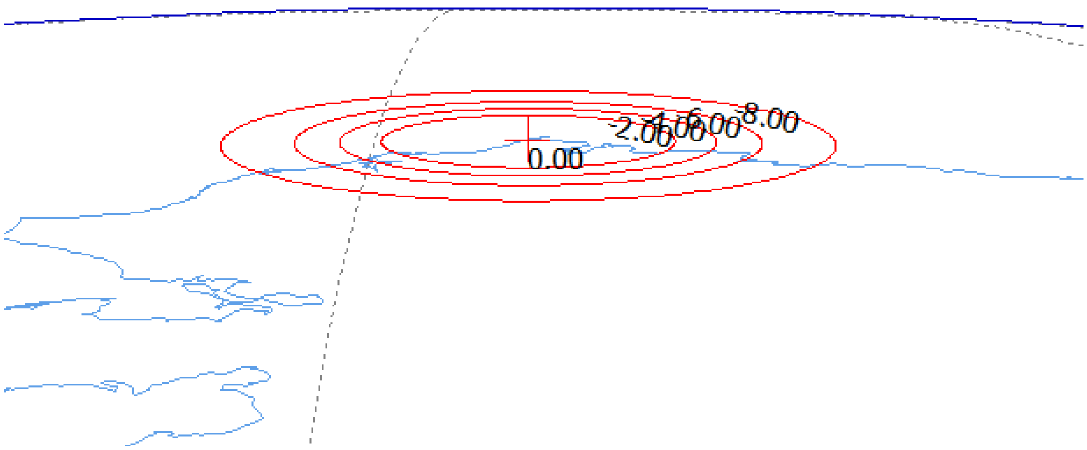


(a)

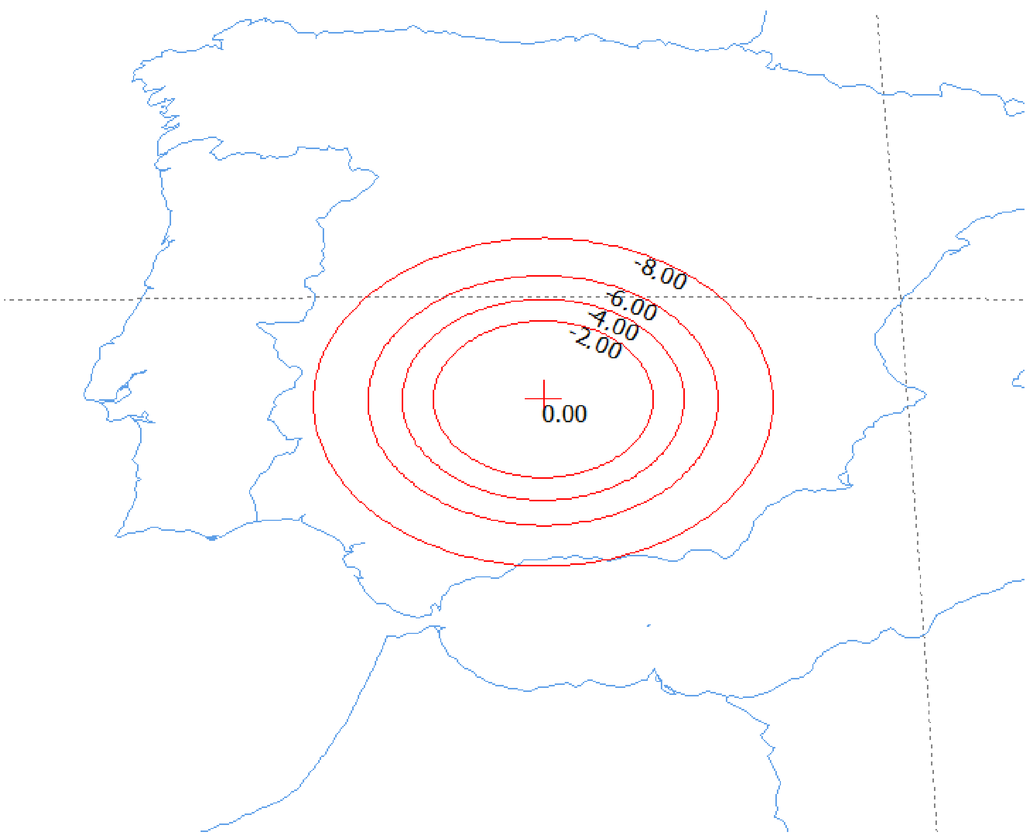


(b)

Figure 9(a, b). X-band transmit downlink gain contours over (a) Alaska and (b) Spain (525 km)



(c)



(d)

Figure 9(a, b). X-band transmit downlink gain contours over (a) Alaska and (b) Spain (300 km)

5. Interference Mitigation and Coexistence

Sidus is committed to coordination and to collaborative operations of its constellation and will optimize the efficient use of allocated spectrum in order to coexist with other space-based and terrestrial users without causing harmful interference.

5.1 Coordination

Sidus is committed to coordinating its proposed operations and frequency usage, and has already engaged government stakeholders NTIA, NOAA, NASA, the U.S. Air Force and Space Force for pre-coordination activities for this mission. Sidus is also in the midst of coordination for two other missions and is aware of the necessary steps for collaboratively engaging with both federal and non-federal operators.

In accordance with 25.273, of the Commission's rules, Sidus will not transmit in any manner that causes unacceptable interference to authorized transmissions of another licensee. Sidus will maintain complete and accurate technical details of current and planned transmissions to aid in the prompt correction of any potential interference, should it occur.

Additionally, since Sidus has selected and is working collaboratively with industry leading ground station providers with established and operational networks, it will ensure the earth stations communicating with the LizzieSat Constellation are located to avoid interference between NGSO systems and between NGSO and GSO systems.

5.2 Protection of Terrestrial Networks by NGSO Systems

The LizzieSat Constellation is compliant with the power flux density ("PFD") limits set out in Article 21 of the ITU's Radio Regulations. The maximum PFD levels for the LizzieSat Constellation were calculated for both S-band downlinks and X-band downlinks. These PFD values are also included in the accompanying Schedule S. Sidus affirms that it will reduce RF power as necessary to always maintain operations within the PFD limits. SIDUS plans to operate down to a minimum orbital altitude of no less than 300 km and the PFD analysis presented below includes this edge case.

Compliance for S-band telemetry (downlink) via the turnstile antenna is furnished in Figure 10 for a 325 km orbit and Figure 11 for a 300 km orbit (the minimum planned operational orbit altitude). This S-band downlink has a maximum EIRP of 5 dBW and the ability to reduce the EIRP down to -15 dBW to assure PFD compliance at all orbit altitudes. This analysis assumes an emission bandwidth of 2.5 MHz. This S-band downlink PFD analysis assumes the peak EIRP can be directed anywhere within the footprint. Sidus reiterates that it will only operate in the S-band downlink outside of the United States for these computations.

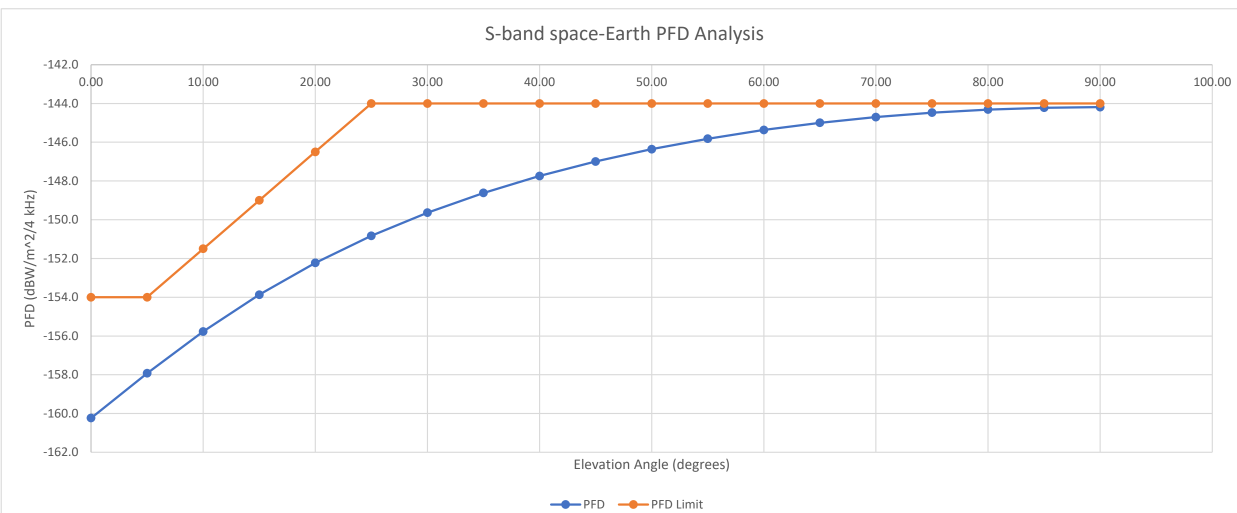


Figure 10. PFD Compliance of Sidus's S-band downlink via Turnstile Antenna (outside the U.S.) for a 5 dBW EIRP emission over 2500 kHz bandwidth at a 325 km orbit

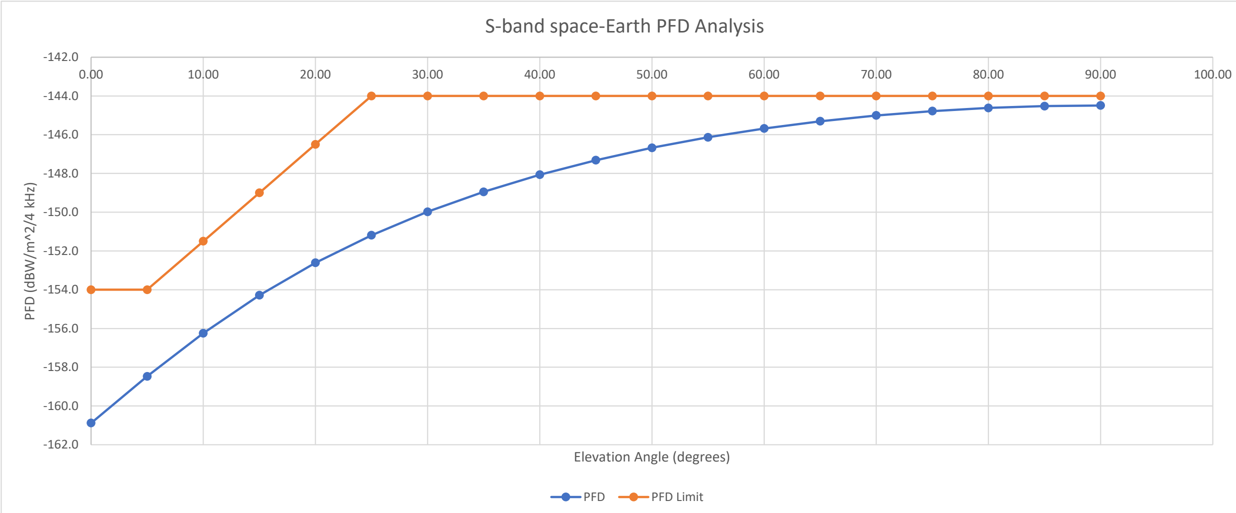


Figure 11. PFD Compliance of Sidus's S-band downlink via Turnstile Antenna (outside the U.S.) for a 4 dBW EIRP emission over 2500 kHz bandwidth at a 300 km orbit

Compliance for S-band telemetry (downlink) via the patch antenna is furnished in Figure 12 for a 400 km orbit and Figure 13 for a 300 km orbit (the minimum planned operational orbit altitude). This S-band downlink has a maximum EIRP of 6.5 dBW and the ability to reduce the EIRP down to -13.5 dBW to assure PFD compliance at all orbit altitudes. This analysis assumes an emission bandwidth of 2.5 MHz. This S-band downlink PFD analysis assumes the peak EIRP can be directed anywhere within the footprint. Sidus reiterates that it will only operate this band outside of the United States for these computations.

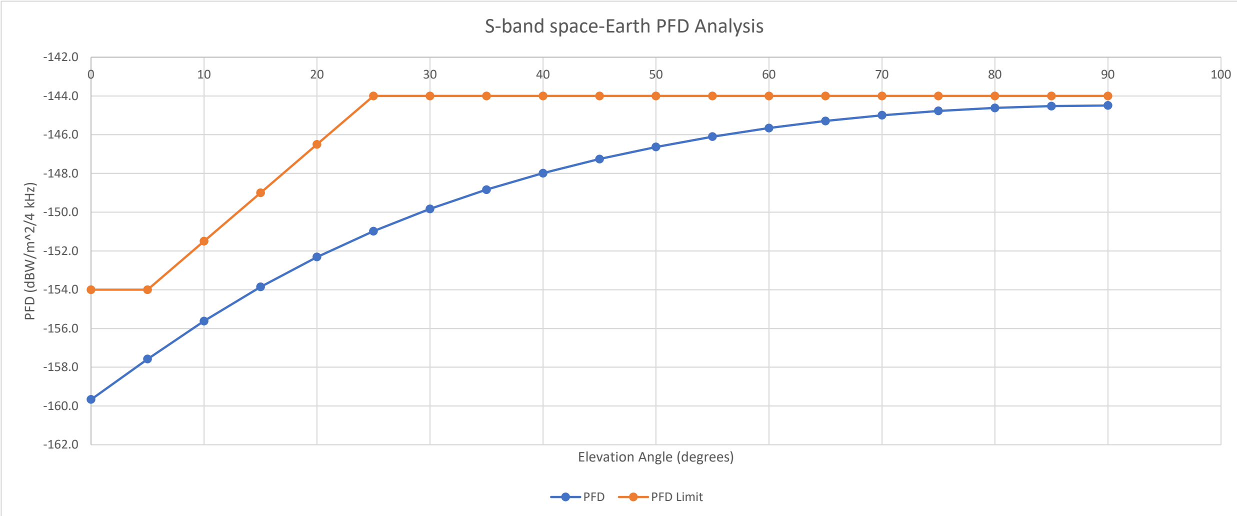


Figure 12. PFD Compliance of Sidus's S-band downlink via Patch Antenna (outside the U.S.) for a 6.5 dBW EIRP emission over 2500 kHz bandwidth at a 400 km orbit

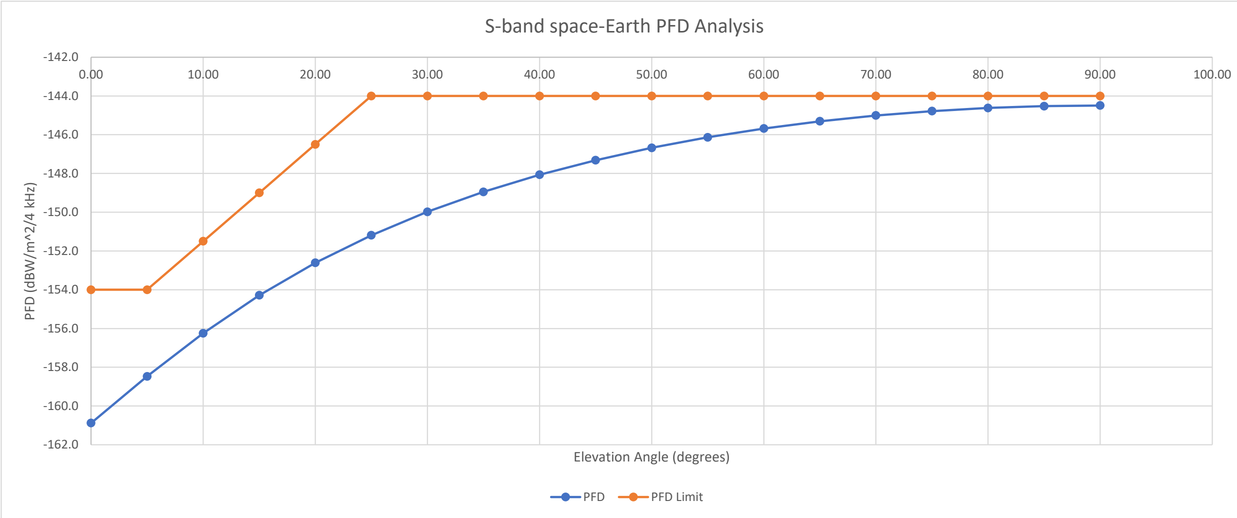


Figure 13. PFD Compliance of Sidus's S-band downlink via Patch Antenna (outside the U.S.) for a 4 dBW EIRP emission over 2500 kHz bandwidth at a 300 km orbit

Compliance for X-band downlink is furnished in Figure 14. The X-band downlink has a maximum EIRP of 15 dBW and the ability to reduce the EIRP down to 9 dBW to assure PFD compliance at all orbit altitudes. This analysis assumes an emission bandwidth of 42 MHz at an orbit altitude of 300 km (the minimum planned operational orbit altitude). The X-band downlink PFD analysis assumes the peak EIRP can be directed anywhere within the footprint.

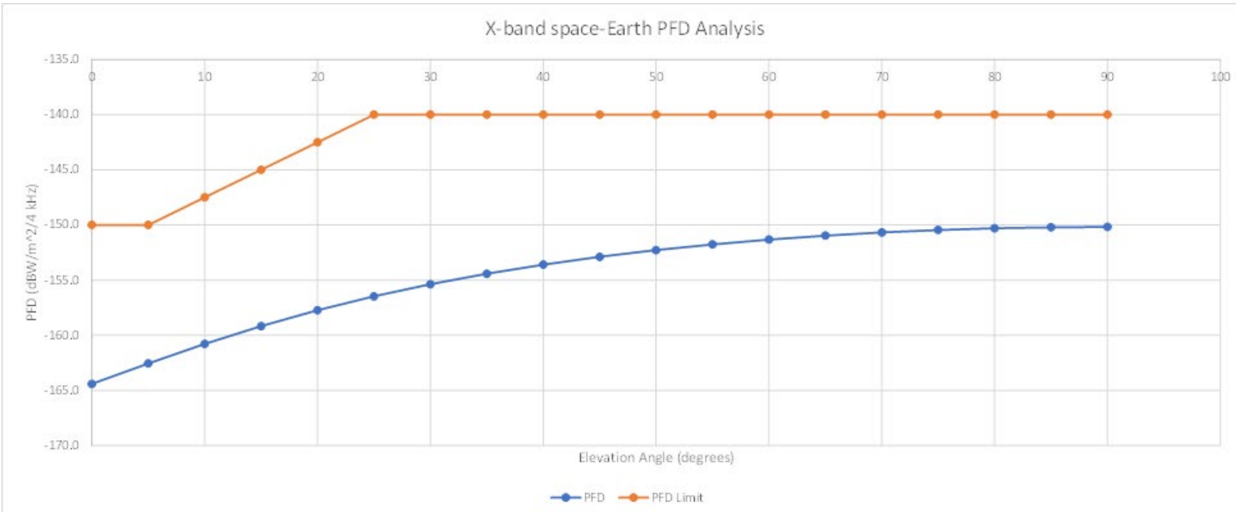


Figure 14. PFD Compliance of Sidus's X-band downlink for a 15 dBW EIRP emission over 42 MHz bandwidth at a 300 km orbit

6. Orbital Debris Mitigation Plan

Sidus confirms that the LizzieSat Constellation will not undergo any planned release of debris during their normal operations (25.114(d)(14)(i)). All separation and deployment mechanisms, and any other potential source of debris, will be retained by the spacecraft. Sidus has assessed the probability of the space stations becoming sources of debris by collision with small debris or meteoroids of less than one centimeter in diameter that could cause loss of control and prevent post-mission disposal. Sidus has taken steps to limit the effects of such collisions through shielding, the placement of components, and the use of redundant systems.

Sidus has assessed and limited the probability of accidental explosions during and after completion of mission operations through a failure-mode verification analysis (25.114(d)(14)(ii)). As part of the satellite manufacturing process, Sidus has taken steps to ensure that debris generation will not result from the conversion of energy sources on board the satellites into energy that fragments the satellites. All sources of stored energy onboard the spacecraft will have been depleted or safely contained when no longer required for mission operations or post-mission disposal.

Sidus has assessed and limited the probability of the space stations becoming a source of debris by collisions with large debris or other operational spacecraft (25.114(d)(14)(iii)). Sidus will work closely with its launch providers to ensure that the satellites are deployed in such a way as to minimize the potential for in-plane collision. This specifically includes minimizing the potential for collision with crewed spacecraft.

Sidus's detailed ODAR is attached as an attachment hereto (25.114(d)(14)(iv)). The disclosure of the orbital deployment parameters, orbital plane inclination, and the orbital period to be used can assist third parties in identifying potential problems. This information also lends itself to coordination between Sidus and other operators located in similar orbits.

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ENGINEERING CERTIFICATION

I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in this application, that I am familiar with Part 25 of the Commission's rules, that I have either prepared or reviewed the engineering information submitted in this application and that it is complete and accurate to the best of my knowledge and belief.

/s/ John Curry
John Curry
Chief Mission Operations Officer
Sidus Space, Inc.

June 13, 2023