EXHIBIT A - TECHNICAL ATTACHMENT

1. SCOPE AND PURPOSE

In support of the application, this Technical Attachment contains technical information required under Part 25 of the Commission's rules.

2. OVERALL DESCRIPTION

2.1. Orbital Information

The Block 3 Tranche 1 satellites are scheduled for launch on a variety of SpaceX rideshare missions (see Table 1 below) and, as such, Umbra has no control regarding the exact right ascension of the ascending node ("RAAN") values for the planes. SpaceX will provide the RAAN values approximately two months prior to each launch. SpaceX has confirmed that Umbra's deployment altitude for the launches will be approximately 590 km. The launch windows for each launch at the time this application is submitted are also indicated in Table 1 below; the windows are subject to change. Upon deployment, Umbra will target a nominal mean equatorial operating altitude of 565 km, with a mean orbital range between 535 km to 595 km (i.e., 565 ± 30 km). During mission life, Umbra may relocate its Block 3 Tranche 1 satellites within the 535 km to 595 km orbital range to reduce conjunction probabilities and to accommodate requests from customers for imaging operations.[1] Also, during the terminal phase of flight at the end of a satellite's useful life, Umbra will continue to use the SAR-sensing capabilities of these satellites throughout the deorbiting process until the satellite reaches a mean altitude of no lower than 325 km, as is described in more detail in the Orbital Debris Assessment Report ("ODAR").

The satellites include an Electrical Propulsion (EP) thruster system that utilizes xenon as its propellant and, through regular corrective propulsive maneuvers conducted by Umbra, are anticipated to remain in their planned orbital range. Representative orbital information is provided in the Schedule S.

[1] *See*, e.g., Stamp Grant, Capella Space Corp., IBFS File No. SAT-LOA-20200914-00108 (granted Dec. 17, 2020) (granting applicant authority to operate within the 525 ± 50 km range).

Table 1. Orbital Parameters

Satellite Number	11	12	13	14
Launch Carrier/Name	SpaceX Transp.-14	SpaceX TSIS-2	SpaceX Transp.-15	SpaceX TBD
Anticipated Launch Timeframe	2025Q2 (June)	2025Q4 (Oct.-Dec.)	2025Q4 (Oct.-Dec.)	2025Q4 (Oct.-Apr.)
Nominal Mean Equatorial Orbit Alt.	565 km, Near Circular	565 km, Near Circular	565 km, Near Circular	565 km, Near Circular
Operating Alt. Range (km)	535-595	535-595	535-595	535-595
Inclination (degree)	97.4 ± 0.1	97.4 ± 0.1	97.4 ± 0.1	53.5 ± 0.1
Eccentricity	Less than 0.004	Less than 0.004	Less than 0.004	Less than 0.004
Sun Sync	No	No	No	No
LTAN (RAAN)*	TBD	TBD	TBD	N/A
Active Service Arc	Full Orbit	Full Orbit	Full Orbit	Full Orbit
Orbital Period (sec)	5749 ± 37	5749 ± 37	5749 ± 37	5749 ± 37

*RAAN to be provided by launch provider approximately two (2) months prior to launch.

2.2. Spectrum

The Block 3 Tranche 1 satellites will operate in the frequency bands shown in Table 2. Spectrum sharing in the proposed S-band and X-band frequencies is possible because the Umbra satellites and satellites in other similar systems transmit and receive only in short periods of time while visible to a receiving or transmitting Earth station. For harmful interference to occur, satellites would have to be visible to the Earth station and transmitting or receiving using the same frequencies at the exact same time. In such an unlikely event, the resulting inline interference can be avoided by commercial operator(s) of the Earth station coordinating the satellite transmissions so that they do not occur simultaneously. Additionally, orbital parameters can also be adjusted such that phasing of the contacts can be offset over time. Umbra's satellites are equipped with propulsion systems which will allow additional maneuverability and phasing throughout their operations. Accordingly, there is no mutual exclusivity between Umbra satellites and other NGSO EESS systems using the same frequency bands.

Table 2. Frequencies of Operation

Link Name	Band (MHz)	Center Frequency (MHz)[2]	Bandwidth (MHz)	Polarization
Mission Data Downlink Band 1	8025–8400	8150	250	RHCP
Mission Data Downlink Band 2	8025–8400	8150	250	LHCP
EESS (Active) Band 1	9200–10400	9800	1200	VV/HH (selectable)
EESS (Active) Band 2	9300–9900	9600	600	VV/HH (selectable)
TT&C Downlink Band 1	2200–2290	2274	0.1	RHCP
TT&C Downlink Band 2	2200–2290	2254	0.1	LHCP
TT&C Uplink Band 1	2025–2110	2100	0.1	RHCP
TT&C Uplink Band 2	2025–2110	2080	0.1	LHCP

2.3. Technology and Operations

The satellites will meet all applicable power flux density ("PFD") and other coexistence requirements even in a worst-case configuration, as discussed below.[3] Moreover, due to the on-demand nature of Umbra's service, its payload and sensing transmissions will occur infrequently and with low PFD on the ground, further minimizing the risk of interference while these systems are active.[4]

2.4. Ground Station Locations

Umbra intends to utilize the ground stations of the Commercial RGTs network listed in the attached document[5] and subject to coordination with Federal spectrum managers for all commercial ground station use. Umbra plans to use both X-Band downlink (Space-to-Earth) and

[2] The center frequencies for the TT&C and data links are representative and may change based on coordination with Federal operators and other users.

[3] *See infra* Section 5.

[4] *See infra* Section 6. *See also* Stamp Grant, Umbra Lab, Inc., IBFS File No. SAT-MOD-20220627-00065; SAT-AMD-20220926-00127 (granted Dec. 1, 2022); Stamp Grant, Umbra Lab, Inc., IBFS File No. SAT-LOA-20230411-00079 (granted October 5, 2023); Stamp Grant, Umbra Lab, Inc., ICFS File No. SAT-LOA-20240222-00038; SAT-AMD-20240329-00070 (partially granted May 27, 2024).

[5] *See* Exh E Ground Station Locations.

S-Band uplink (Earth-to-Space) and downlink (Space-to-Earth) to communicate with these commercial ground stations, as well as with Federal ground stations. As indicated in the above referenced attachment, Umbra will communicate with U.S.-based Commercial RGTs only through X-Band downlink and S-Band uplink.

3. Predicted Space Station Antenna Gain Patterns and Contours

Block 3 Tranche 1 satellites will use several fixed antennas for payload and TT&C communications, as well as SAR sensing. The gain patterns and contours for each of these antennas are illustrated below.

3.1. X-Band Mission Data Downlink (8025–8400 MHz)

The Umbra X-Band mission data downlink beam will have a maximum EIRP of 23.2 dBW using the spectrum allocations shown in Table 2 above with the gain patterns shown in Figure 1 below. Block 3 Tranche 1 will operate using X-Band communications by means of a patch antenna, as depicted below in Figure 1 and Figure 2. Interference analysis for the band is provided in this document in sections 5.2, 5.4, and 6.2-6.5.

Figure 1. Umbra X-Band Downlink Gain Pattern (4x4)

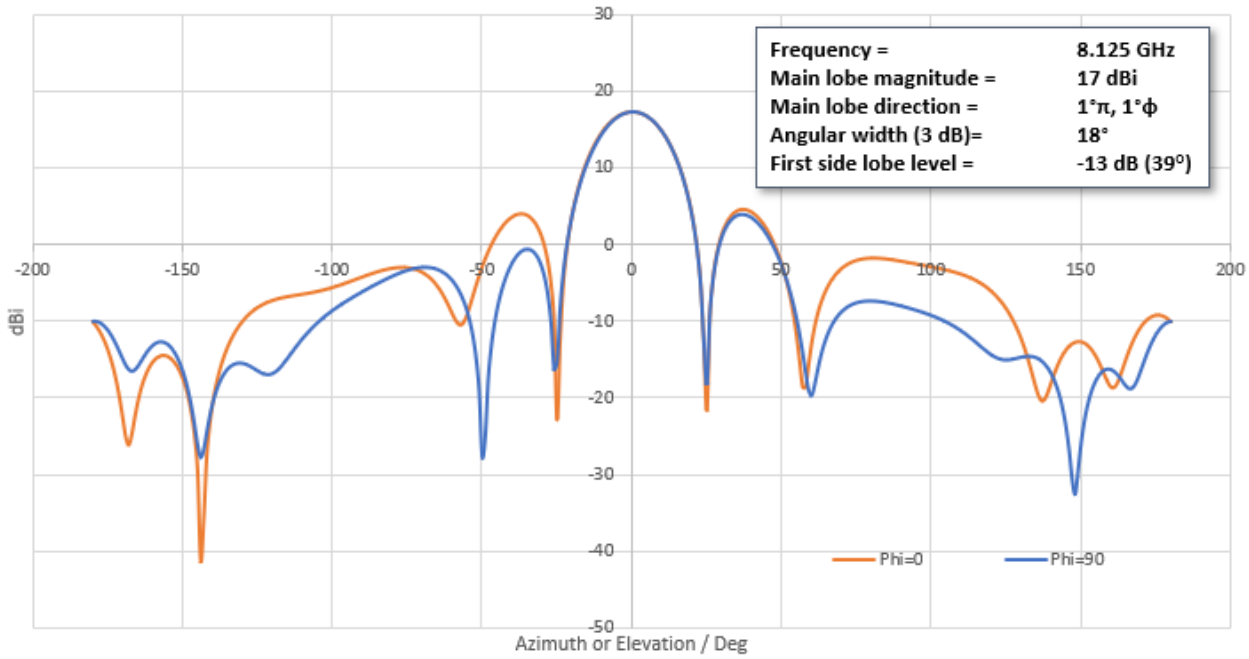
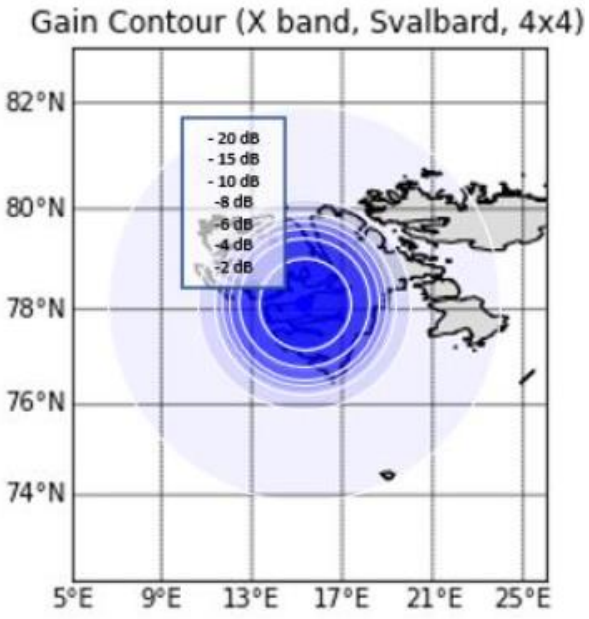


Figure 2. Umbra X-Band Gain Contours (Svalbard, 4x4)



3.2. S-Band TT&C Downlink (2200–2290 MHz)

The S-Band TT&C downlink beam will have a maximum EIRP of -9 dBW in a 100 kHz channel centered at 2274 MHz with RHCP and 2254 MHz with LHCP polarization (Band 1 and Band 2, respectively) with the gain patterns shown in Figure 3 and the gain contours in Figure 4.

Figure 3. Umbra S-Band TT&C Downlink Gain Pattern

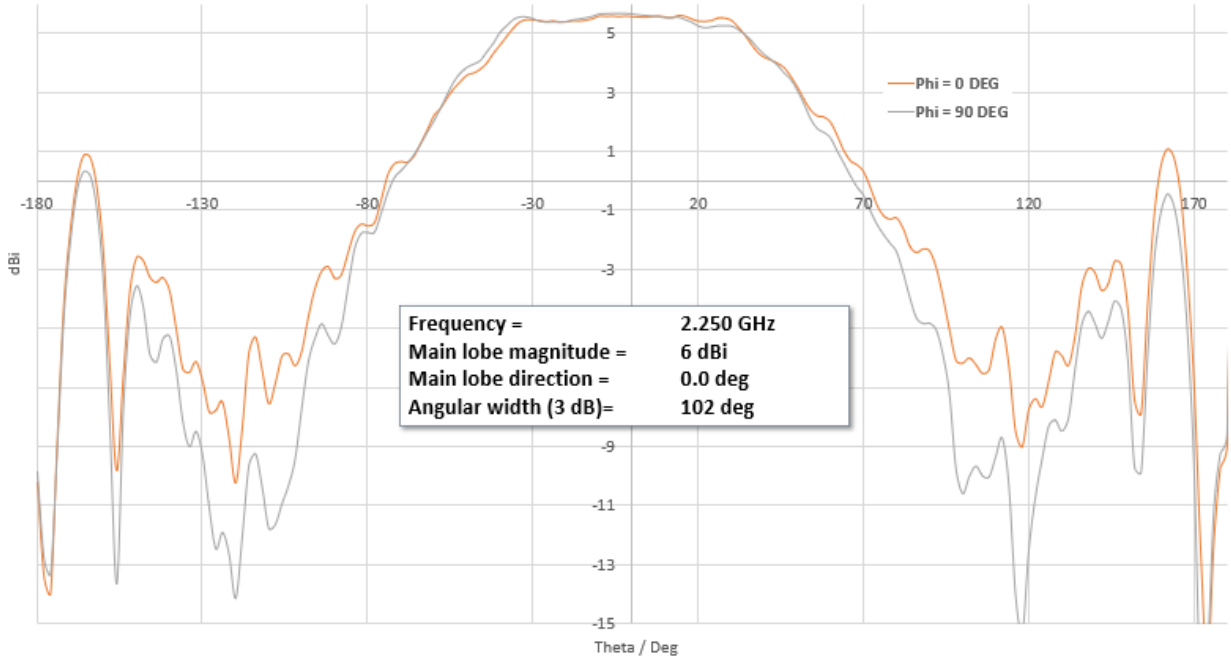
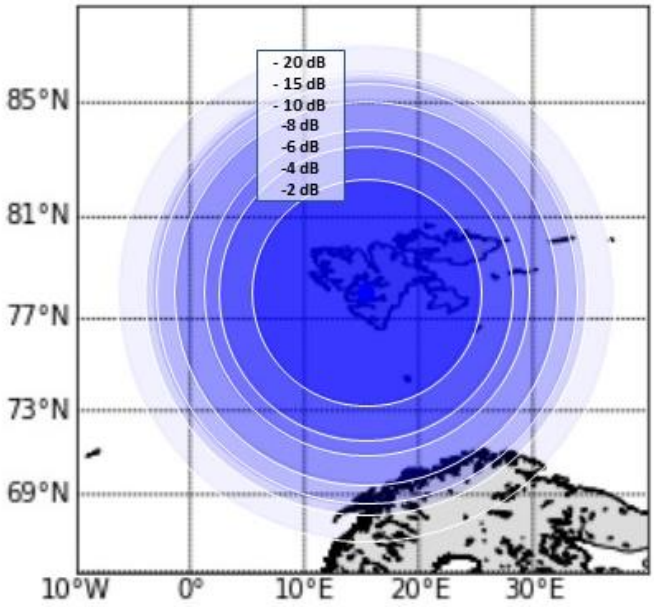


Figure 4. Umbra Maximum Footprint S-Band Gain Contours (Svalbard)



3.3. X-Band SAR Instrument

Block 3 Tranche 1 satellites generate brief pulses using a very high directivity antenna thus minimizing both the active time as well as the affected areas on the ground. Umbra plans to utilize two alternative frequency channels for its SAR payload. The SAR utilizes linear polarization and can operate at HH or VV. As described in the table below, the Umbra X-band radar beam will have a maximum EIRP of 76.9 dBW for Umbra-11 through Umbra-13 and up to 83dBW for Umbra-14. These transmissions utilize one of two alternative frequencies centered at 9600 MHZ and 9800 MHz with bandwidths of 600 MHz and 1200 MHz respectively, using linear polarization, with the gain pattern shown in Figure 5 and the gain contours in Figure 6 below.

Figure 5. Umbra X-Band SAR Gain Pattern

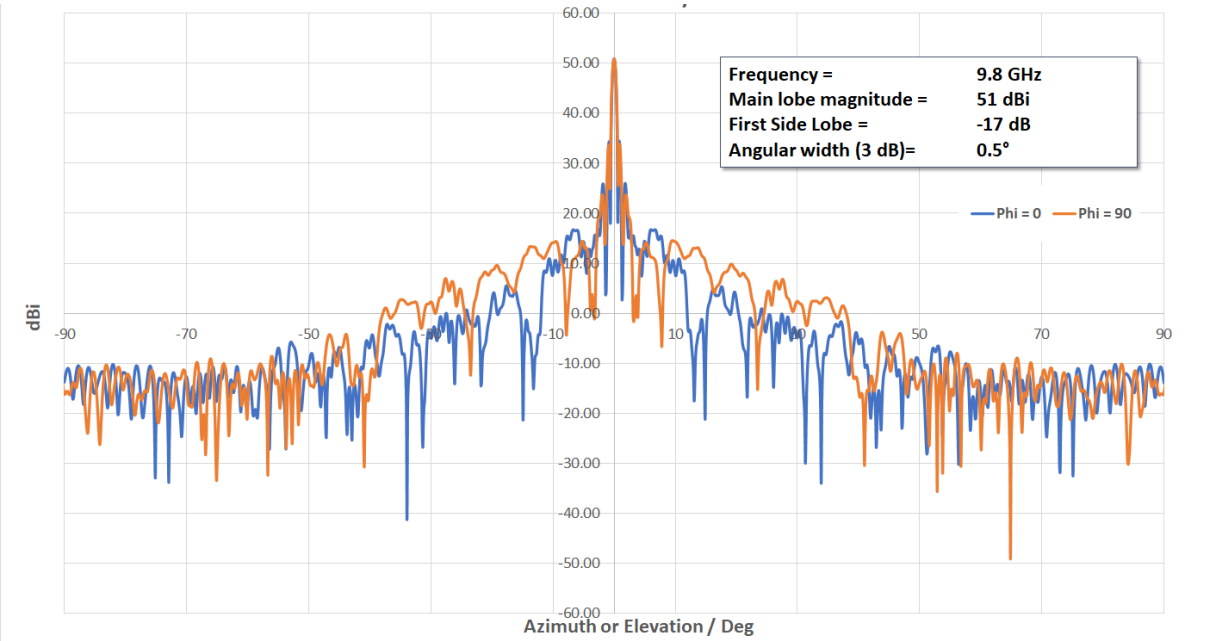
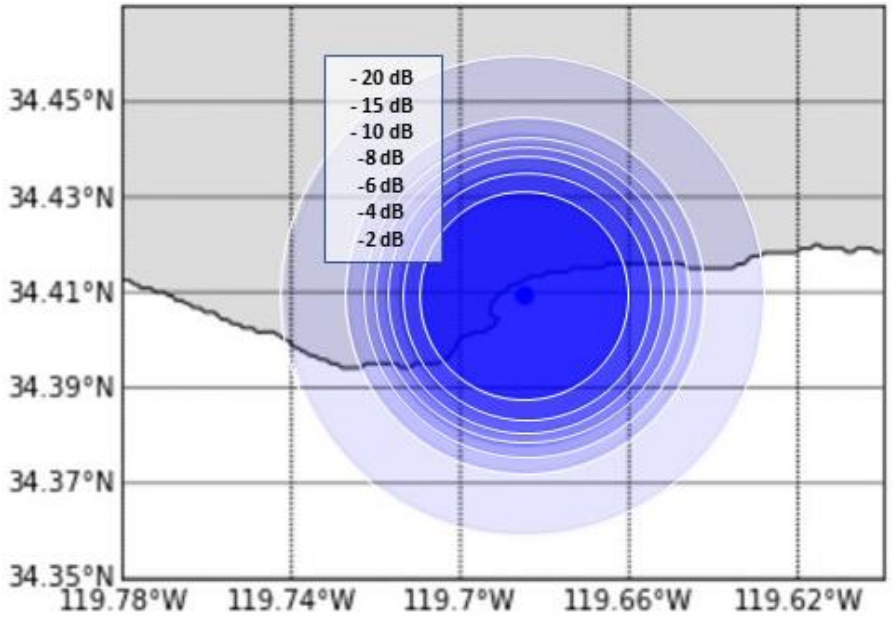


Figure 6. Umbra SAR Gain Contours (Santa Barbara)



4. CESSATION OF EMISSIONS

Each active satellite transmission chain (channel amplifiers and associated power amplifier) can be individually turned on and off by ground telecommand, thereby causing definite cessation of emissions from the satellites, as required by Section 25.207 of the Commission's rules.

5. COMPLIANCE WITH PFD LIMITS AND OTHER SHARING CRITERIA

This section demonstrates that the satellites will operate with PFD below specified limits. For each band shown, a worst-case approach was taken to show compliance in even the most outlying case. At each satellite's end of mission life Umbra may continue to leverage the SAR-sensing capabilities of its systems throughout the deorbiting process to an altitude of no lower than 325 km. Therefore, all worst-case PFD analyses below are calculated at an operational altitude of 325 km for sustained SAR operations and communications during deorbit Post Mission Disposal ("PMD") operations.

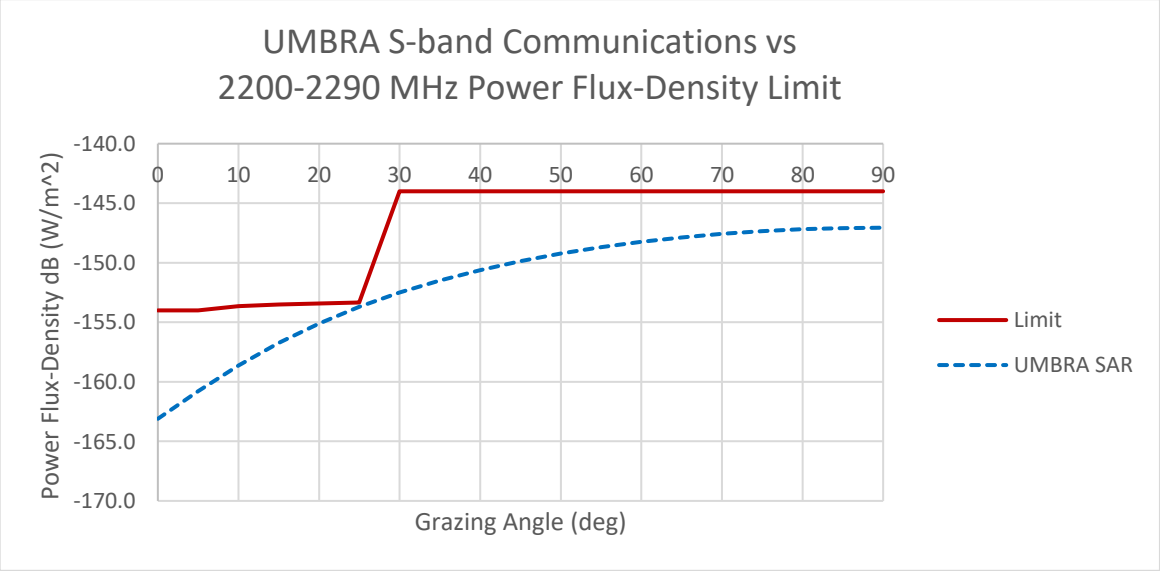
5.1. Power Flux Density in the Band 2200–2290 MHz

In accordance with note US303 of the U.S. Table of Frequency Allocations, the PFD at Earth's surface from non-Federal stations shall not exceed -144 to -155 dBw/m^2/kHz, depending on the angle of arrival, in accordance with ITU Radio Regulation 21.16.[6] Further, following the PMD plan at the end of the satellites' useful lifetime, the EIRP of this communications channel will remain compliant with PFD limits as shown in Figure 7 throughout deorbit operations. Lastly, to ensure that interference with any Deep Space Research ("DSR") communications within the adjacent frequency spectrum at 2290-2300 MHz remains below -222.5 dB (W/(m^2 Hz)), per ITU-R SA.1157-1, Umbra operates such that the highest band edge within the operating frequencies (2275 MHz) is at least 14 MHz below the lower edge of the DSR band. Additionally, digital and RF filtering, assures compliance with SA.1157-1.

Figure **7. Nominal Power Flux Density for S-Band (2200–2290 MHz)**7 shows that each satellite complies with the PFD limit of ITU Radio Regulation 21.16 at all angles of arrival. This analysis assumes peak antenna gain and is thus valid for all vehicle attitude states. Further, the onboard radio power may be adjusted to further reduce power as required to mitigate interference.

[6] 47 C.F.R. § 2.106 n.US303.

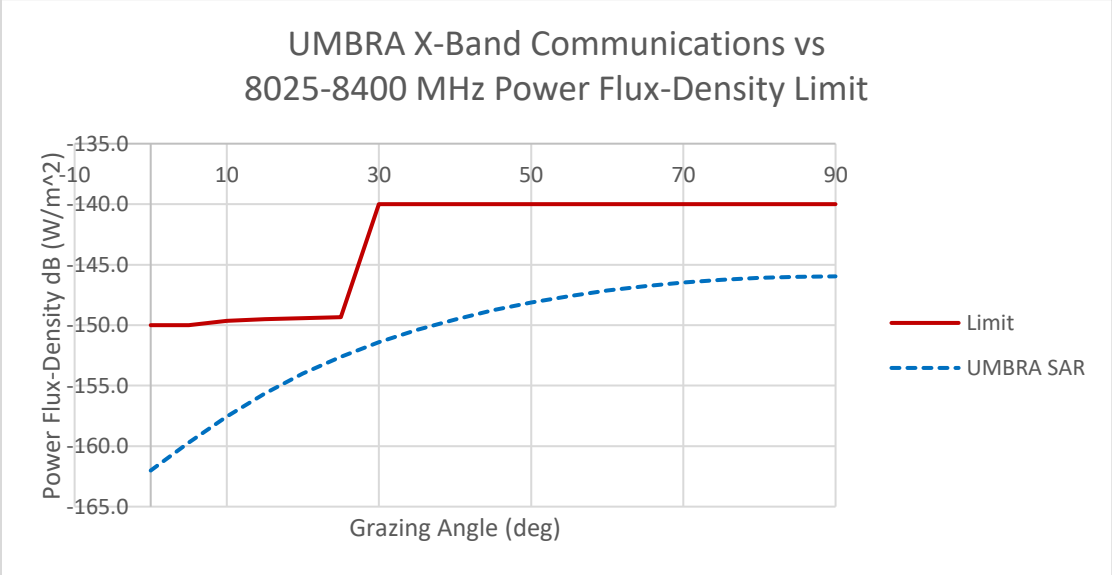
Figure 7. Nominal Power Flux Density for S-Band (2200–2290 MHz)



5.2. Power Flux Density in the Band 8025–8400 MHz

To ensure that interference with any DSR communications within the adjacent frequency spectrum at 8400–8450 MHz remains below -221 dB(W/(m^2 Hz)), per ITU-R SA.1157-1, Umbra plans to operate such that the highest band edge within the operating frequencies (8300 MHz) is at least 100-MHz below the lower edge of the DSR band. Additionally, digital and RF filtering, assures compliance with SA.1157-1. Figure 8 shows PFD for X-band communications at 325 km altitude plotted against the ITU limit, demonstrating that this channel will never exceed the recommended limits.

Figure 8. Nominal Power Flux Density for X-Band (8025-8400 MHz)

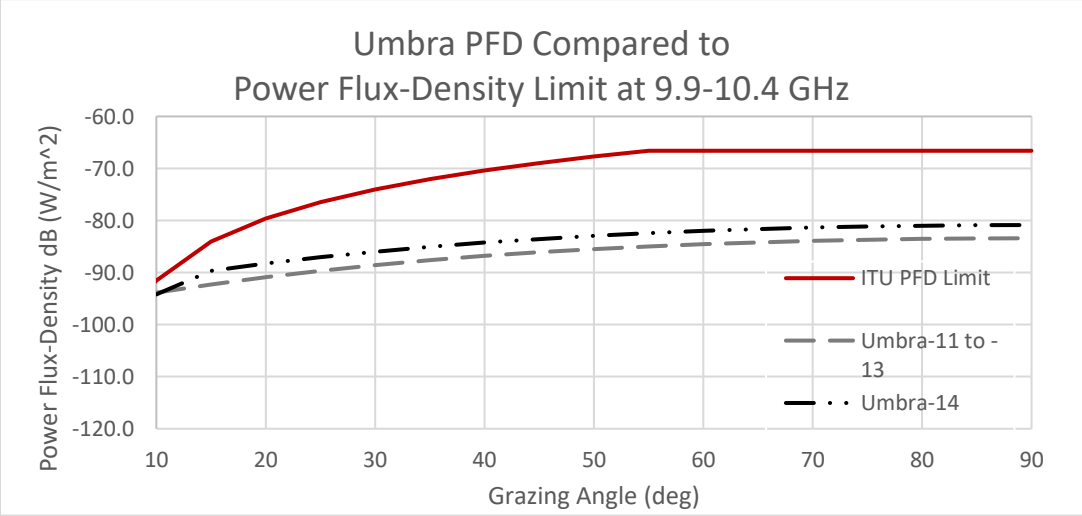


5.3. Power Flux Density in the Band 9900–10400 MHz

PFD limits between 9900–10400 MHz are identified in Table 21-4 in ITU Radio Regulation Section 21.16.[7] Figure 9 shows the simulated worst-case PFD for all possible collection angles using bandwidths greater than 600 MHz compared to the allowable limits. Note that though Figure 9 shows grazing angles from 10 to 90 degrees, for grazing angles below 20 degrees, Umbra does not utilize more than 600 MHz of bandwidth for nominal operations and thus for these geometries does not occupy the band limited by the ITU.

[7] ITU Radio Regulations, Vol. 1: Articles, Art. 21 § 21.16, at 294, Table 21-4 (2024).

Figure 9. Power Flux Density for X-Band (9.9–10.4 GHz)[8]



5.4. Power Flux Density at the Geostationary Satellite Orbit

Article 22, Section II, Part 22.5 of the ITU Radio Regulations specifies that in the frequency band 8025–8400 MHz, which the EESS (using non-geostationary satellites) shares with the fixed-satellite service (Earth-to-space) and the meteorological-satellite service (Earth-to-space), the maximum PFD produced at the geostationary satellite orbit ("GSO") by any EESS space station shall not exceed –174 dBW/m^2 in any 4 kHz band.[9] The calculation below shows that the PFD produced by the transmissions from the proposed satellites does not exceed the limit in Section 22.5, even in the worst possible hypothetical case. The PFD at the GSO produced by the satellite transmission is:

$$PFD\left[\frac{dBW}{m^2 \cdot 4\,kHz}\right] = EIRP\,[dBW] - 71 - 20\log_{10} D - 10\log_{10} BW - 24$$

EIRP is the maximum EIRP of the transmission in dBW; D is distance between the satellite and GSO in km; BW is the signal bandwidth of the transmission in MHz; the minimum possible distance between the satellite and the GSO is $35{,}786 - 595 = 35{,}191\ km$.

[8] ITU limits per Section 5, Table 21.47

[9] ITU Radio Regulations, Vol. 1: Articles, Art. 22 § II, part 22.5, at 305 (2024).

Under a hypothetical assumption that an Umbra satellite antenna is radiating at its peak EIRP toward the GSO, with the peak $EIRP = 23.2\ dBW$ and $BW = 250\ MHz$ produces a PFD at the GSO of

$$-276.7\ \frac{dBW}{m2 \cdot 4kHz}$$

Even in this worst-case scenario, the PFD is well below the specified maximum.

5.5. Protection of Terrestrial Radar and Radiolocation Beacons

Footnote 5.427 of the ITU and U.S. Table of Frequency Allocations specifies that responses from EESS radar transponders are not to be confused with responses from radar beacons and prohibits responses from radar transponders from causing harmful interference to ship or aeronautical radars.[10] Umbra's satellites will not operate as radar transponders nor will Umbra's SAR transmissions in this band be confused with radar or radiolocation beacons due to the fundamentally different timing, duration, and other characteristics of radar beacon signals compared to Umbra's SAR transmissions. Accordingly, this footnote is not applicable.

5.6. Compliance with Applicable ITU Notes for 9200–9300 MHz and 9900–10400 MHz Frequency Bands

5.6.1. Note 5.474A: The use of the frequency bands 9200–9300 MHz and 9900–10400 MHz by the EESS (active) is limited to systems requiring necessary bandwidth greater than 600 MHz that cannot be fully accommodated within the frequency band 9300–9900 MHz.[11] Umbra satellites require necessary bandwidth greater than 600 MHz as stated and is committed to obtaining agreements for coordination under No. 9.21 and will work with the Bureau to do so if necessary.

[10] *See* 47 C.F.R. § 2.106 n.5.427.

[11] Such use is subject to agreement to be obtained under No. 9.21 from Algeria, Saudi Arabia, Bahrain, Egypt, Indonesia, Iran (Islamic Republic of), Lebanon and Tunisia. An administration that has not replied under No. 9.52 is considered as not having agreed to the coordination request. In this case, the notifying administration of the satellite system operating in the Earth exploration-satellite service (active) may request the assistance of the Bureau under Sub-Section IID of Article 9. (WRC-15).

5.6.2. Note 5.474B: Stations operating in the EESS (active) shall comply with Recommendation ITU-R RS.2066-0 (WRC-15). As described below, no RAS sites will be imaged without prior coordination.[12]

5.6.3. Note 5.474C: Stations operating in the EESS (active) shall comply with Recommendation ITU-R RS.2065-0 (WRC-15). As described below, interference in bands from 8400 MHz to 8500 MHz is not possible.[13]

5.6.4. Note 5.474D: Stations in the EESS (active) shall not cause harmful interference to, or claim protection from, stations of the maritime radionavigation and radiolocation services in the frequency band 9200–9300 MHz, the radionavigation and radiolocation services in the frequency band 9900–10 000 MHz, and the radiolocation service in the frequency band 10.0–10.4 GHz. (WRC-15) As described above, interference with maritime radionavigation and radiolocation is not possible.[14] For additional information, please see applicable interference analysis provided in Exhibit C.[15]

5.6.5. Note 5.475A: The use of the band 9300–9500 MHz by the EESS (active) and the space research service (active) is limited to systems requiring necessary bandwidth greater than 300 MHz that cannot be fully accommodated within the 9500–9800 MHz band.[16] Umbra requires bandwidth greater than 300 MHz to operate its SAR payload. Accordingly, use of the 9300–9500 MHz band is appropriate.

5.6.6. Note 5.476A and 5.478B: Umbra transmissions have different waveforms, short transmission, and very low duty cycle, and thus are extremely unlikely to interfere with radionavigation and radiolocation services in the 9300-9800 MHz band, or stations of the fixed service in the 9800-9900 MHz band. Further, radionavigation, radiolocation, and signals from stations of the fixed service cannot be confused with Umbra's transmissions due to the fundamentally different timing, duration, and other characteristics of such signals compared to Umbra's SAR transmissions. Similar to how the Umbra system's analog and digital filtering

[12] *See infra* Section 6.7

[13] *See infra* Section 6.5.

[14] *See supra* Section 5.5.

[15] *See* Interference Analysis.

[16] 47 C.F.R. § 2.106 n. 5.475A

prevents transmissions from these services from having an impact on the formation of SAR images, systems on the ground are similarly protected and as such are unlikely to suffer from interference from Umbra transmissions, so long as Umbra transmissions comply with PFD limits. Even in the highly unlikely case where one of these stations had no digital filtering, Umbra's transmissions to any point on Earth are so short and utilize such a low duty cycle that the impact would be rare and inconsequential. Accordingly, Umbra complies with footnotes 5.476A and 5.478B.

5.6.7. Note 5.478A: The use of the band 9800–9900 MHz by the EESS (active) and the space research service (active) is limited to systems requiring necessary bandwidth greater than 500 MHz that cannot be fully accommodated within the 9300–9800 MHz band.[17] Umbra's SAR transmissions require more than 500 MHz of bandwidth. Accordingly, use of the 9800–9900 MHz band is appropriate.

5.6.8. Note 5.427: As discussed in Section 5.5 above**,** Umbra's satellites will not operate as radar transponders, therefore, this note is not applicable.[18]

6. INTERFERENCE ANALYSIS

6.1. S-Band Downlink (2200–2290 MHz)

Umbra plans to transmit over S-band downlink to earth stations outside of the U.S. As described in Section 2.2, the Umbra S-Band TT&C Downlink will operate within the 2200–2290 MHz band. Transmissions occur with a maximum EIRP of -9 dBW in a 100 kHz channel centered at 2274 MHz using RHCP polarization and 2254 MHz using LHCP polarization.[19] Interference between Umbra satellites and other systems is unlikely because EESS systems operating in the 2200–2290 MHz band normally transmit only in short periods of time while visible from the dedicated receiving earth stations (typically less than 10 minutes for a single pass). Further, the earth station beam required to intercept the transmitted signal is highly directive and Umbra satellites will only use up to 0.1 MHz of bandwidth. Each satellite will also be configured so as not to exceed the

[17] *Id.* at n. 5.478A.

[18] *See supra* Section 5.5.

[19] These are representative channels. The use of this frequency band is subject to coordination with Federal operators and the specific channels may change as a result.

PFD limit for non-Federal space stations.[20] Therefore, spectrum sharing in this band is possible and Umbra's operations will not cause harmful interference to other operators.[21]

6.2. X-Band Downlink (8025–8400 MHz)

Umbra will utilize X-Band within the 8025–8400 MHz band for high bandwidth mission data downlink. As described in section 2 above, the Umbra X-Band mission data downlink will utilize the lower end of the band occupying 250 MHz from 8025–8275 MHz. Transmissions occur with a maximum EIRP of <23.2 dBW centered at 8150 MHz using RHCP and LHCP polarization.[22] Umbra has performed analysis showing that required interference mitigation and PFD requirements are met.[23] Umbra will exercise mitigation techniques outlined in the ECC Report 115 for operating its satellite downlink in the 8025–8400 MHz band.[24] Below are the key steps taken to minimize risk of interference.

- Satellites will operate in a non-broadcast mode, only radiating when transmitting data to one or more of the planned earth stations;
- Satellites will employ a directional antenna;
- Satellites will operate well within the PFD limits for all emissions; and
- Satellites will operate in the lower portion of the 8025–8400 MHz band.

6.3. Interference Between EESS Systems Operating in the Band 8025–8400 MHz

Interference between Umbra satellites and those of other systems is unlikely because EESS systems operating in the 8025–8400 MHz band normally transmit only in short periods of time

[20] *See supra* Section 5.1.

[21] *See supra* Narrative, Section I.B.4.ii.

[22] This is a representative channel. The use of this frequency band is subject to coordination with Federal operators and the specific channel may change as a result.

[23] *See supra* Section 5.2.

[24] *See* Electronic Communications Committee (ECC) within the European Conference of Postal and Telecommunications Administration (CEPT), Use of the Frequency Band 8025–8400 MHz by EESS, ECC Report 115 (Ljubljana, January 2008).

while visible from the dedicated receiving earth stations (typically less than 10 minutes for a single pass).

Umbra's satellites are designed to operate in non-broadcast mode. For interference to happen, satellites belonging to different systems would have to travel through the antenna beam of the receiving earth station and transmit at the same time and at same frequency. In such a very unlikely event, interference can still be avoided by coordinating the satellite transmissions with the respective operators so that they do not occur simultaneously. In addition, orbital parameters can be adjusted such that phasing of the contacts can be offset over time.

6.4. Interference with the Fixed Service and the FSS in the Band 8025–8400 MHz

As shown above, the Umbra satellites will meet the limits specified by the ITU for protection of geostationary fixed satellite service ("FSS") satellites in the 8025–8400 MHz band.[25]

6.5. Protection of the Deep Space Research in the Band 8400–8450 MHz

Umbra will use the lower 250 MHz of the 8025–8400 MHz band, leaving a guard band of 125 MHz to protect the 8400–8450 MHz band as well as using a directive antenna as shown in Section 3.1. Further, Umbra utilizes a programmable digital filter and hardware filter on our X-band radio to ensure that these transmissions are always in compliance with ITU out-of-band emissions recommendations. The satellites will not be intentionally commanded to transmit unless the main beam is oriented towards a licensed earth station.

6.6. X-Band Radar (9200–10400 MHz)

As shown above, the Umbra satellites will meet the limits specified by the ITU for protection of the FSS in the 9900–10400 MHz band.[26]

6.7. Protection of the Radio Astronomy Service in the Frequency Band 10.6–10.7 GHz

[25] *See supra* Section 5.4.

[26] *See supra* Section 5.3.

To avoid damage to sensitive radio astronomy service ("RAS") low noise amplifiers, ITU Recommendation RS.2066-0 provides an operational procedure to avoid main-beam to main-beam coupling between EESS (active) SAR systems transmitting near 9600 MHz and RAS stations performing observations in the 10.6–10.7 GHz band.[27]

In accordance with this Recommendation, Umbra will:

- Establish geographic exclusion zones ("GEZ") around RAS sites, e.g., all RAS sites listed in ITU-R RS.2066-0;
- Operate using a 9600 MHz center frequency when bandwidth requirements do not exceed 600 MHz when in range of RAS GEZs; and
- Coordinate with RAS operators prior to illumination.

7. COORDINATION WITH U.S. GOVERNMENT SYSTEMS

There are a number of Federal allocations in the bands proposed to be used by the Block 3 Tranche 1 satellites. Umbra has provided various U.S. government spectrum managers information on the operational parameters of its system and is committed to successful coordination with all relevant government satellite and terrestrial networks. Umbra is confident that the characteristics of its proposed system will facilitate an operational approach that allows Umbra to share this spectrum with government systems without harmful interference. Umbra has successfully coordinated spectrum use for its Block 1, Block 2 and Block 2.1 satellites and has also engaged in informational exchange with federal spectrum managers regarding the satellites covered by this application.

8. ORBITAL DEBRIS MITIGATION

Umbra has incorporated the material objectives set forth in this application into the technical specifications established for design and operation of its NGSO system. Umbra has internally reviewed orbital debris mitigation requirements and has incorporated them, as appropriate, into its operational plans.[28] A more detailed description of the orbital debris mitigation plan is included in

[27] *See generally* Protection of the radio astronomy service in the frequency band 10.6-10.7 GHz from unwanted emissions of synthetic aperture radars operating in the Earth exploration-satellite service (active) around 9 600 MHz, Recommendation ITU-R RS.2066-0, RS SERIES - REMOTE SENSING SYSTEMS (Dec. 2014).

[28] *See* 47 C.F.R. § 25.114(d)(14); Orbital Debris Assessment Report (ODAR).

the ODAR. For convenience, a high-level summary of the ODAR is provided below. Additionally, because Umbra-14's launch window may extend into mid-2026, that satellite may host an updated radar design. Accordingly, Umbra is including analysis in the orbital debris assessment report for this satellite ("Umbra-14 ALTERNATE"). However, for completeness, we have included an analysis of satellite Umbra-14 that is identical to satellites Umbra 11-13 in the ODAR in case the launch occurs earlier in the launch window. Umbra will inform the FCC in the post-launch notification which radar design is aboard Umbra-14.

8.1. Spacecraft Hardware Design

No debris is released during normal satellite operations. Umbra is aware of the possibility that its system could become a source of debris in the unlikely event of a collision with small debris or meteoroids that could either create jetsam or cause loss of control of the spacecraft and prevent PMD. However, Umbra satellites include on-board propulsion systems, which will be used to actively reduce the probability of collision with other known objects. Umbra has assessed the probability of collision using the most recent version of NASA's Debris Assessment Software (DAS v.3.2.6) and is compliant with every applicable NASA standard, as shown in its ODARs attached hereto as Exhibit B.

Umbra incorporates redundancy, shielding, separation of components, and other physical characteristics into the satellites' design. The propulsion system will contain xenon as propellant. The satellites will not expel any other matter besides the xenon gas used as fuel during thrust events, and this inert gas simply dissipates into space after use. Therefore, there is no source of debris from operation of the propulsion system.

8.2. Minimizing Accidental Explosions

Umbra designs its spacecraft in a manner that limits the probability of accidental explosion. Umbra has assessed the possibility of accidental explosions during and after completion of mission operations through a failure mode verification analysis. As part of the satellite manufacturing process, Umbra has taken steps to ensure that debris generation will not result from the conversion of energy sources onboard the Umbra satellites into energy that fragments the satellites. The only

areas of the spacecraft that will store any significant amount of energy are its batteries and pressurant tank used for propulsion.

These sources of energy will be depleted or safely contained when they are no longer required for mission operations or to accomplish PMD, further minimizing risk. The tanks are designed to contain pressurized xenon gas. The worst case on-orbit tank pressure for a full tank is 2000 psi. The tank temperature is not expected to exceed 40°C on orbit. The tanks have been designed and tested to 6527 psi. There is a 350% margin on the tank's working pressure, ensuring that there is no risk of accidental explosion of the propulsion system.

8.3. Safe Flight Profiles

Through detailed mission planning, Umbra has carefully assessed and limited the probability of its system becoming a source of debris by collisions with large debris or other operational space stations. Prior to deployment, Umbra will register all satellites with the United States Space Force's ("USSF") 18th and 19th Space Defense Squadrons ("SDS") (or its successor entity). Following deployment, Umbra will identify and track its satellites using each satellite's unique telemetry marker and a network of ground stations. Because the satellites will be larger than 10 cm in their smallest dimension, they are presumed to be trackable. DAS analysis shows that the probability of collision with a large object is 0.00008, which is well below the 0.001 requirement.

Umbra confirms that it intends to perform collision avoidance procedures, including conjunction assessment, execution of avoidance maneuvers, trajectory planning and conjunction assessment, and notification to other potentially affected operators of any significant planned alteration of a satellite's trajectory for all phases of operations. Umbra will be continuously coordinating with the SDS (or its successor entity) through their existing conjunction reporting database to proactively address conjunction alerts. Upon receipt of a space situational awareness conjunction warning, Umbra will review and take all possible steps to assess and mitigate the collision risk as necessary. As appropriate, steps to assess and mitigate the collision risk may include but are not limited to: contacting the operator of any active spacecraft involved in such a warning; sharing ephemeris data and other appropriate operational information with any such operator; and modifying space station attitude and/or operations. Umbra will also be proactive in mitigating any risks from its deorbiting satellites to inhabitable orbiting objects, including, for example, the International Space Station ("ISS"). Umbra has a demonstrated track record of adherence to these procedures through

its operations of ten on-orbit spacecraft. Through these measures, Umbra will continue to be able to avoid collisions on an ongoing basis.

8.4. Safety Of Flight Contingency Operations

While preparations can be made to help assure that there will never be a fault on orbit, it is not reasonable to take on Class A levels of mission assurance and adhere to the company's mission of providing low-cost, high quality, SAR data products. The resulting requirement is to create a balance between reasonable measures of redundancy with the ability to recover if a fault occurs onboard or from one of the ground stations beyond our control. From the very first orbit, and throughout the intended mission life, Umbra expects that at least once per orbit there is an opportunity to communicate with one of our ground stations and receive new tasking. If, through one of the aforementioned faults, Umbra satellites exceed a configurable threshold for the number of minutes (orbits) exceeded without contact from the ground station network, the satellites have the ability to attempt to autonomously re-connect with our ground terminals located outside the U.S. over our TT&C channel. This approach has been discussed in pre-coordination with Federal spectrum managers for the previously authorized licenses and successfully tested on orbit.

9. POST-MISSION DISPOSAL

Each satellite in the Block 3 Tranche 1 is designed for a useful lifetime of five years and will be disposed of through atmospheric re-entry. Umbra will deorbit all satellites within the applicable six-year license term[29] to ensure that the total in-orbit lifetime of each satellite is six years or less as required.[30] A more detailed discussion of the post-mission disposal plan is provided in Exhibit B.[31]

[29] 47 C.F.R. § 25.121(a)(3) (licenses for applications filed pursuant to § 25.122 shall be issued for a period of six-years).

[30] 47 C.F.R. § 25.122(c)(2) ("The total in-orbit lifetime for any individual space station will be six years or less").

[31] *See* ODAR, Section 7.3.

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.

UMBRA LAB, INC.

By: /s/ Alexander Potter

Alexander Potter

UMBRA LAB, INC.

Dated: January 8, 2025