ATTACHMENT A

Technical Appendix

A.1 SCOPE AND PURPOSE

This Technical Appendix provides the Federal Communications Commission ("FCC" or "Commission") with the information not captured in the associated Schedule S regarding the technical characteristics of Intuitive Machines, LLC's ("Intuitive Machines") Lunar Data Network ("LDN") constellation, named Altus ("Altus" or "Altus Constellation"). Intuitive Machines developed the Altus Constellation to provide cislunar relay communications services pursuant to Category 2.2 of the National Aeronautics & Space Administration's ("NASA") Near Space Network Services ("NSNS") contract. The Altus Constellation will include five (5) non-geostationary spacecraft ("Altus-1," "Altus-2," "Altus-3," "Altus-4," and "Altus-5") orbiting the Moon providing long-haul communication services from missions on the lunar surface and low lunar orbits to ground stations on Earth.[1]

The first Altus satellite, Altus-1, is currently planned to launch in Q4 2026, and Intuitive Machines respectfully requests that the Commission consider and authorize the proposed operations as soon as reasonably practicable. Intuitive Machines will update the Commission with the final launch date once the launch schedule is finalized.

A.2 GENERAL DESCRIPTION

Intuitive Machines seeks authority to operate the proposed Altus satellites under the Commission's small spacecraft rules.[2] Altus-1 is expected to launch in Q4 2026, Altus-2 and Altus-3 are expected to launch in Q4 2027, and Altus-4 and Altus-5 are expected to launch in 2028.

The Altus Constellation will operate in four phases: (i) Launch Phase; (ii) Transit Phase; (iii) Operational Lunar Orbit Phase; and (iv) Post-Mission Disposal Phase.

Each Altus satellite is planned to be launched aboard a SpaceX Falcon 9 rocket. During the Launch Phase,[3] Intuitive Machines' control facility in Houston will expeditiously establish communications with each individual Altus satellite to begin tracking the spacecraft and computing Trajectory Correction Maneuver ("TCM") burns.

During the Transit Phase, each Altus satellite will perform a Ballistic Lunar Transfer ("BLT") trajectory that will last 120-170 days. The BLT will include a lunar flyby 5-10 days after launch, a long coast phase lasting between 110-160 days, during which each Altus satellite's maximum distance can reach 1.5 million km from Earth, and a return to the Moon for Lunar Orbit Injection ("LOI"). Throughout the Transit Phase, several trajectory maneuvers will be performed to properly target the operational orbit.

[1] Due to technical difficulties in ICFS, Section S3.a of the associated Schedule S pre-populated with an inaccurate number of simultaneously operating satellites in the Altus Constellation. For clarity, the the Altus Constellation involves only five simultaneously operating satellites.
[2] *See* 47 C.F.R. § 25.123; *see also In the Matter of Streamlining Licensing Procedures for Small Satellites*, IB Docket No. 18-86, Report and Order, 34 FCC Rcd 13077 (rel. Aug. 2, 2019) ("*Smallsat Order*").
[3] Launch Phase consists of the launch itself, as well as the period immediately after launch and launch vehicle separation.

During the Operational Lunar Orbit Phase, the Altus Constellation will orbit the Moon in an Elliptical Lunar Frozen Orbit ("ELFO") with an orbit period of approximately 33 hours. This phase's duration will be evaluated in conjunction to spacecraft health until retirement is initiated.

The Post-Mission Disposal Phase will consist of identifying primary and backup lunar craters to target for disposal of each Altus satellite, followed by controlled maneuvers to place the Altus satellite on trajectory for safe disposal within the selected lunar crater. The Altus satellites have been designed with adequate propulsive capabilities to retire in this manner, and Intuitive Machines will track the Altus satellite to impact on the lunar surface. The Post-Mission Disposal Phase is explained further in Section A.17 below.

Intuitive Machines' Altus Constellation satellites have been engineered to achieve an operational life of approximately six years. Intuitive Machines anticipates replacing spacecraft as appropriate to support NASA NSNS and commercial clients. Should Intuitive Machines need to extend the proposed Commission authority to operate the Altus Constellation beyond the initial license term, appropriate authority shall be requested under the Commission's small spacecraft rules or alternative rules of general applicability that may have been adopted in the interim.

A.3 ALTUS SATELLITE OVERVIEW

The Altus satellite will be delivered to orbit via SpaceX's Falcon 9 rocket on a standard 24" diameter port of an ESPA Grande payload adapter ring. The satellite is deployed in a direction perpendicular to the launch vehicle longitudinal axis by means of a 24" diameter SEOPS Keystone separation band. The quick-release Keystone band includes 18 permanently retained separation springs that impart a uniform separation velocity to the Altus satellite with minimal tipoff.

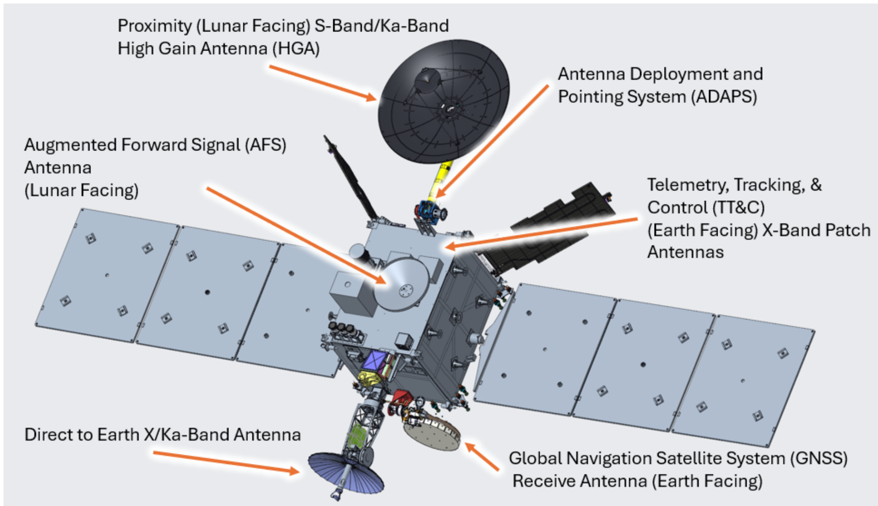
The Altus-1 propulsion system is a hydrazine monopropellant propulsion system, with sixteen 4N Reaction Control System ("RCS") thrusters and eight 28N main thrusters. The propellant is stored in a single propellant tank, separated by helium pressurant gas via a flexible diaphragm, and will operate in blowdown throughout the duration of the mission. Attitude determination is achieved with redundant inertial measurement units ("IMU") and star trackers. Attitude control is primarily conducted via a redundant reaction wheel assembly, with the ability to swap to the dual-redundant monopropellant RCS.

The Altus-1 propulsion system will be utilized in three primary phases. The first phase includes placing the spacecraft into its correct orbit around the Moon, by performing a series of burns including TCM, Deep Space Maneuvers ("DSM") and an LOI utilizing both the main thrusters and RCS. The second phase will include momentum wheel desaturation and orbit maintenance maneuvers. The RCS thrusters will be used for momentum wheel desaturation at periodic intervals, and the main thrusters will be utilized to perform orbit maintenance maneuvers. The third phase includes the disposal burn of the spacecraft. This will be performed by the spacecraft main thrusters.

The Altus satellites utilize a three-axis stabilized bus, with a dry mass of approximately 519 kg and an approximate wet mass of 640 kg. The deployed envelope measures 749 x 342 x 198 centimeters. Two fixed body-mounted, three segment solar panels produce 2600 Watts at beginning-of-life ("BOL") and 2000 Watts at end-of-life ("EOL"), with energy stored in four 825 Watt-hour

Lithium-ion batteries and an unregulated 28 volts direct current ("VDC") bus voltage. A representative view of an Altus satellite is shown in Figure A.3-1.

Figure A.3-1: Side View of the Altus Satellites



A.4 ORBITAL PARAMETERS

The Altus satellites will be inserted into a direct trajectory to the Moon by the SpaceX Falcon 9 booster. Deployment will occur at an altitude of approximately 650 km. The deployment orbit will be approximately 410,000 km x 200 km in altitude, with an inclination of approximately 28 degrees. Once in lunar orbit, the Altus satellites will adhere to the orbital parameters in Table A.4-1 below.

Table A.4-1: Lunar Orbital Parameters

Satellite	Orbit Plane*	Apolune Radius	Perilune Radius	Inclination
Altus-1	1	20,370 km	3,640 km	56.25 degrees
Altus-2	2	20,370 km	3,640 km	56.25 degrees
Altus-3	2	20,370 km	3,640 km	56.25 degrees
Altus-4	3	20,370 km	3,640 km	56.25 degrees
Altus-5	3	20,370 km	3,640 km	56.25 degrees

* Each orbit plane will be separated in right ascension of the ascending node ("RAAN") by 120 degrees from the other planes.

A.5 SPECTRUM USAGE

The Altus Constellation will use X- and Ka-bands for Earth-to-space and space-to-Earth communications and S- and Ka-bands for cislunar (proximity) communications. The Earth-to-space, space-to-Earth, and cislunar communications can support NASA's LunaNet Interoperability

Frequency Plan.[4] A description of the spectrum usage for the Altus Constellation is shown in Table A.5-1 below.

Table A.5-1: General Radiofrequency Use Plan

Description	Communications Link	Frequency Range	Service
Earth-facing (RX)	Earth to relay	22.55-23.15 GHz	Mission uplink
	Earth to relay	7190-7235 MHz	Mission uplink
	GNSS to relay	1164-1215 MHz	GNSS
	GNSS to relay	1559-1610 MHz	GNSS
Lunar-facing (Proximity RX)	Lunar surface to relay	25.5-27 GHz	Proximity return (non-LunaNet)
	Lunar surface to relay	27-27.5 GHz	Proximity return
	Lunar surface to relay	2200-2290 MHz	Proximity return
	Lunar surface to relay	2483.5-2500 MHz	AFS
Earth-facing (TX)	Relay to Earth	25.5-27 GHz	Mission downlink
	Relay to Earth	8450-8500 MHz	Mission downlink
Lunar-facing (Proximity TX)	Relay to lunar surface	22.55-23.15 GHz	Proximity forward (non-LunaNet)
	Relay to lunar surface	23.15-23.55 GHz	Proximity forward
	Relay to lunar surface	2025-2110 MHz	Proximity forward
	Relay to lunar surface	2483.5-2500 MHz	AFS

At any given time, there will be one operational Telemetry, Tracking and Command ("TT&C") forward link and one return link per Altus satellite. TT&C communications can be performed using the X-band Patch antenna to provide low-data rate broad coverage independent of spacecraft pointing, or with the High Gain Antenna ("HGA") for high data rate while on-station.

The Altus communication system uses two identical software-defined radios ("SDR") manufactured by Lucix, configured as a primary and redundant unit. The Altus-1 SDR is a software-controlled encoding and modulating device capable of concurrently supporting up to 7 channels in the Ka-, X-, and S-bands. Once the frequency leaves the SDR, it is appropriately amplified and routed to the correct antenna.

The Earth-to-space and space-to-Earth links use an X-/Ka-band dual-feed 0.7m HGA, and are used to service high-rate data and primary TT&C. An X-band Patch antenna will be used for transfer orbit and off-nominal TT&C. Cislunar communications are provided over an S-/Ka-band dual-feed 1.5m HGA to service high-rate user data. The remaining channel is an Augmented Forward Signaling ("AFS") channel providing customers Position, Navigation, and Timing ("PNT") information over a .4m S-band horn antenna.

The Altus satellites also have a Global Navigation Satellite Systems ("GNSS") antenna and separate receiver that operates in the L-band. The satellites receive and process GNSS signals to compute the current position, velocity and time. This information is provided to lunar PNT users

[4] *See* LunaNet Interoperability Specification Document, Version 5, available at: https://www.nasa.gov/wp-content/uploads/2025/02/lunanet-interoperability-specification-v5-baseline.pdf?emrc=606f95.

to compute their own position, velocity and time. The GNSS antenna receives terrestrial GNSS data via a gimballed L-band antenna. This data is routed to a dedicated GNSS receiver, decoded and fed into Intuitive Machines' customer algorithm as part of a solution to determine SC time and position for PNT service that is provided to lunar users.

Table A.5-2 provides channel, frequency, and bandwidth of the Altus Constellation relay-to-Earth transmit beams.[5] All Earth-to-space, space-to-Earth and AFS communications utilize right-hand circular polarization ("RHCP"). Similarly, Table A.5-3 provides channel, frequency, and bandwidth of the Altus Constellation relay-to-lunar surface transmit beams ("Proximity Links").[6] The Proximity Links utilize left-hand circular polarization ("LHCP") and RHCP. The center frequencies and bandwidths for the Proximity Links are input for purposes of this Application as placeholders. Intuitive Machines' customers will apply for separate FCC authority for Proximity Link communications, which Intuitive Machines will then service. Intuitive Machines will provide updates to the FCC, in a format acceptable to the Commission, when its customers select Proximity Link center frequencies and bandwidths.

Transponder "turnaround ratios" in accordance with NASA's *DSN Frequency and Channel Assignments*[7] were used to select the Altus Earth-to-space and space-to-Earth frequencies. Turnaround ratios provide phase coherency between uplink and downlink signals allowing more precise measurement of 2-way and 3-way Doppler shift. The X-band turnaround ratio used was 880/749 (downlink/uplink). Multiple ratios were used for Ka-band.

Multiple center frequencies can be used by any Altus satellite for the X- and Ka-bands and are therefore listed in the following tables. This provides Intuitive Machines the flexibility to change frequencies, if necessary, due to interference or coordination. However, each Altus satellite will operate on only one X-band and one Ka-band frequency pair at a time.

Table A.5-2: Transmitting (Downlink) Channels – Relay-to-Earth[8]

Schedule S Channel ID	Channel Bandwidth, MHz	Center Frequency, MHz	Service Link or TT&C
T081, T082, T091, T092	8, 16	8459	TT&C
T083, T084, T093, T094	8, 16	8467	TT&C
T085, T086, T095, T096	8, 16	8475	TT&C
T087, T088, T097, T098	8, 16	8483	TT&C
T089, T090, T099, T100	8, 16	8491	TT&C

[5] *See* 47 C.F.R. § 25.114(c)(4)(i)-(ii).
[6] *See id*.
[7] *See* Deep Space Network, 201 Frequency and Channel Assignments, available at: https://deepspace.jpl.nasa.gov/dsndocs/810-005/201/201F.pdf.
[8] Due to limitations in the Schedule S software, only a single service category may be entered for transmitting channels. Intuitive Machines clarifies that any of the bandwidth modes can carry telemetry and/or data (service).

Schedule S Channel ID	Channel Bandwidth, MHz	Center Frequency, MHz	Service Link or TT&C
T001, T002, T003, T004, T005	8, 16, 134, 156	25587.57	Service Link
T006, T007, T008, T009, T010	8, 16, 134, 156	25664.82	Service Link
T011, T012, T013, T014, T015,	8, 16, 134, 156	25742.18	Service Link
T016, T017, T018, T019, T020,	8, 16, 134, 156	25819.65	Service Link
T021, T022, T023, T024, T025	8, 16, 134, 156	25897.25	Service Link
T026, T027, T028, T029, T030	8, 16, 134, 156	25974.96	Service Link
T031, T032, T033, T034, T035	8, 16, 134, 156	26052.78	Service Link
T036, T037, T038, T039, T040	8, 16, 134, 156	26130.72	Service Link
T041, T042, T043, T044, T045	8, 16, 134, 156	26208.78	Service Link
T046, T047, T048, T049, T050	8, 16, 134, 156	26286.96	Service Link
T051, T052, T053, T054, T055	8, 16, 134, 156	26384.30	Service Link
T056, T057, T058, T059, T060	8, 16, 134, 156	26481.83	Service Link
T061, T062, T063, T064, T065	8, 16, 134, 156	26560.41	Service Link
T066, T067, T068, T069, T070	8, 16, 134, 156	26648.67	Service Link
T071, T072, T073, T074, T075	8, 16, 134, 156	26727.50	Service Link

Schedule S Channel ID	Channel Bandwidth, MHz	Center Frequency, MHz	Service Link or TT&C
T076, T077, T078, T079, T080	8, 16, 134, 156	26816.05	Service Link

Table A.5-3: Transmitting (Downlink) Channels – Relay-to-Lunar Surface

Schedule S Channel ID	Channel Bandwidth, MHz	Center Frequency, MHz	Service Link or TT&C
T101, T102, T103, T104, T105, T106, T107	2, 5, 10, 25, 50, 100, 200	22850	Service Link
T108, T109, T110, T111, T112, T113, T114	2, 5, 10, 25, 50, 100, 200	23350	Service Link
T115, T116, T117, T118	2, 5, 10, 20	2067.5	Service Link
T119, T120, T121	2, 5, 10	2491.75	Service Link

Tables A.5-4 and A.5-5 provide corresponding channel frequency and bandwidth of the Altus receive beams.

Table A.5-4: Receiving (Uplink) Channels – Earth-to-Relay

Schedule S Channel ID	Channel Bandwidth, MHz	Center Frequency, MHz	Service Link or TT&C
R097, R098, R099, R112, R113, R114	.004, 8, 16	7199.762	TT&C
R100, R101, R102, R115, R116, R117	.004, 8, 16	7206.571	TT&C
R103, R104, R105, R118, R119, R120	.004, 8, 16	7213.380	TT&C
R106, R107, R108, R121, R122, R123	.004, 8, 16	7220.189	TT&C
R109, R110, R111 R124, R125, R126,	.004, 8, 16	7226.998	TT&C

Schedule S Channel ID	Channel Bandwidth, MHz	Center Frequency, MHz	Service Link or TT&C
R001, R002, R003, R004, R005, R006	.004, 5, 10, 20, 40, 60	22585.00	TT&C and Service Link
R007, R008, R009, R010, R011, R012	.004, 5, 10, 20, 40, 60	22620.00	TT&C and Service Link
R013, R014, R015, R016, R017, R018	.004, 5, 10, 20, 40, 60	22655.00	TT&C and Service Link
R019, R020, R021, R022, R023, R024	.004, 5, 10, 20, 40, 60	22690.00	TT&C and Service Link
R025, R026, R027, R028, R029, R030	.004, 5, 10, 20, 40, 60	22725.00	TT&C and Service Link
R031, R032, R033, R034, R035, R036	.004, 5, 10, 20, 40, 60	22760.00	TT&C and Service Link
R037, R038, R039, R040, R041, R042	.004, 5, 10, 20, 40, 60	22795.00	TT&C and Service Link
R043, R044, RO45, R046, R047, R048	.004, 5, 10, 20, 40, 60	22830.00	TT&C and Service Link
R049, R050, R051, R052, R053, R054	.004, 5, 10, 20, 40, 60	22865.00	TT&C and Service Link
R055, R056, R057, R058, R059, R060	.004, 5, 10, 20, 40, 60	22900.00	TT&C and Service Link
R061, R062, R063, R064, R065, R066	.004, 5, 10, 20, 40, 60	22935.00	TT&C and Service Link
R067, R068, R069, R070, R071, R072	.004, 5, 10, 20, 40, 60	22970.00	TT&C and Service Link
R073, R074, R075, R076, R077, R078	.004, 5, 10, 20, 40, 60	23005.00	TT&C and Service Link
R079, R080, R081, R082, R083, R084	.004, 5, 10, 20, 40, 60	23040.00	TT&C and Service Link
R085, R086, R087, R088, R089, R090	.004, 5, 10, 20, 40, 60	23075.00	TT&C and Service Link

Schedule S Channel ID	Channel Bandwidth, MHz	Center Frequency, MHz	Service Link or TT&C
R091, R092, R093, R094, R095, R096	.004, 5, 10, 20, 40, 60	23110.00	TT&C and Service Link

Table A.5-5: Receiving (Uplink) Channels – Lunar Surface-to-Relay

Schedule S Channel ID	Channel Bandwidth, MHz	Center Frequency, MHz	Service Link or TT&C
R127, R128, R129, R130, R131, R132, R133	2, 5, 10, 25, 50, 100, 200	26250	Service Link
R134, R135, R136, R137, R138, R139, R140	2, 5, 10, 25, 50, 100, 200	27250	Service Link
R141, R142, R143, R144	2, 5, 10, 20	2245	Service Link
R145, R146, R147	2, 5, 10	2491.75	Service Link

Uplink and downlink communication with the Altus satellites will be supported by three ground stations in the U.S.: Morehead State University ("Morehead") in Kentucky,[9] the Brewster Gateway,[10] and the Catawissa Gateway.[11] Additionally, the Altus satellites will be supported by the Goonhilly ground station in the United Kingdom, as well as NASA's DSN as set forth in Section A.10 below. Additional ground station sites will be added on an ongoing basis as the Altus Constellation develops, at which time Intuitive Machines will supplement the application with additional information.

A.6 LUNAR TELEMETRY, TRACKING, AND CONTROL

The Altus satellite flight computer will use the Consultative Committee for Space Data Systems ("CCSDS") standard 131.0-B-1 regarding TM Synchronization and Channel Coding as well as CCSDS 732.0-B-3 regarding the Advanced Orbiting Systems ("AOS") Space Data Link Protocol for telemetry formatting. The Altus flight computer will encrypt all data before it is sent to the radios for transmission to Earth and decrypt all data sent from Earth.

A.7 COMMUNICATIONS PACKAGE

[9] Morehead will separately seek special temporary authority to support the Altus mission. Intuitive Machines will support Morehead in this effort as appropriate.
[10] File number SES-LIC-20260110-00794 and Call Sign E260184.
[11] File number SES-LIC-20260312-00628 and Call Sign E260194.

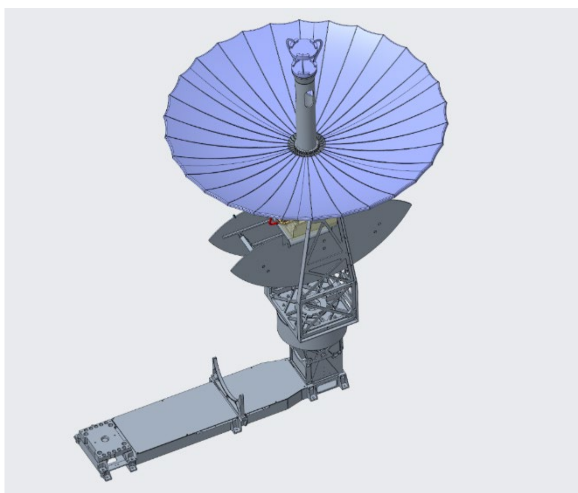
Each Altus satellite will have three Earth-facing antennas. The parameters for these antennas are set forth in Table A.7-1.

Table A.7-1: Parameters of the Altus Satellite Earth-Facing Antennas

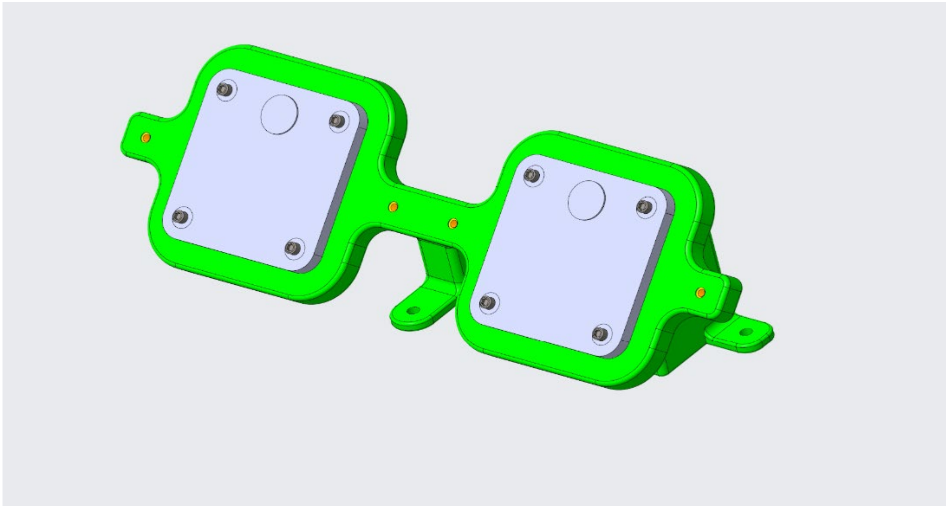
Antenna Type	Quantity	Mid-band RX Gain, dBi	Mid-band TX Gain, dBi
Earth-facing 0.7m X-/Ka-band HGA	1	40.8 (Ka-band) 32 (X-band)	42.7 (Ka-band) 32.3 (X-band)
Earth-facing X-band Patch antenna	1	8	6.3
Earth-facing GNSS antenna	1	18.1	N/A

Figure A.7-1 shows a representative diagram of the Earth-facing antennas on an Altus satellite.

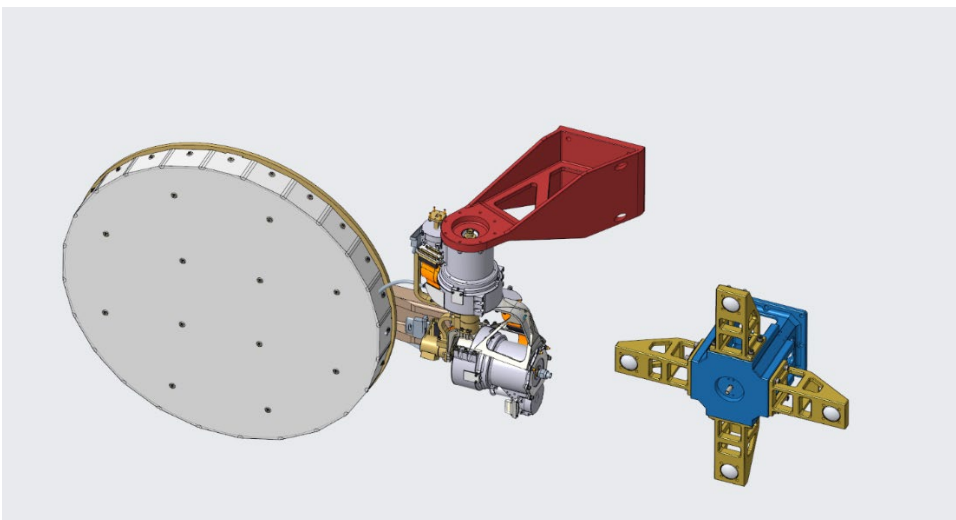
Figure A.7-1: Altus Satellite Earth-Facing Antenna Diagrams



Earth-facing 0.7m X-/Ka-band HGA



Earth-facing X-band Patch antenna



Earth-facing GNSS antenna

Each Altus satellite will have two lunar-facing antennas. The parameters for these antennas are set forth in Table A.7-2.

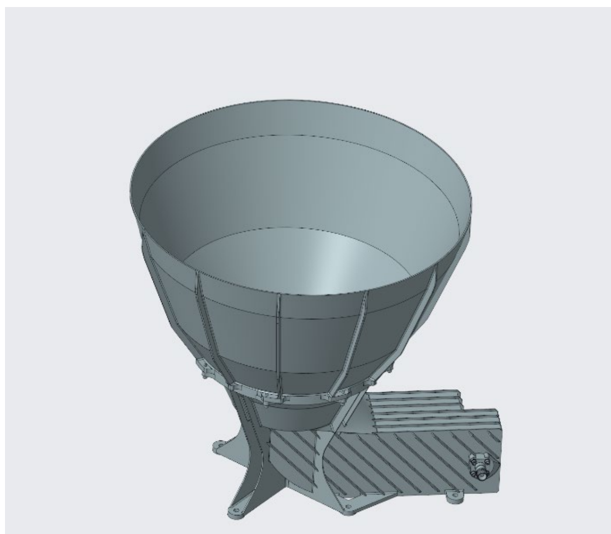
Table A.7-2: Parameters of the Altus Satellite Lunar-Facing Antennas

Antenna Type	Quantity	Mid-band RX Gain, dBi	Mid-band TX Gain, dBi
Lunar-facing 1.25m S-/Ka-band HGA	1	48.6 (Ka-band) 25.9 (S-band)	47.3 (Ka-band) 26.0 (S-band)
AFS S-band horn	1	16.8	16.9

Figure A.7-2 shows a representative diagram of the lunar-facing antennas on an Altus satellite.

Figure A.7-2: Altus Satellite Lunar-Facing Antenna Diagrams

Lunar-facing 1.25m S-/Ka-band HGA



Lunar-facing 0.4m AFS S-band horn antenna

A.8 PREDICTED SPACE STATION ANTENNA GAIN CONTOURS

Antenna gain contours for Altus satellites are provided in GXT format in the GIMS database as part of this application and are also reproduced below in Figures A.8-1 through A.8-13.

Figure A.8-1: Earth-facing X-band Patch TX

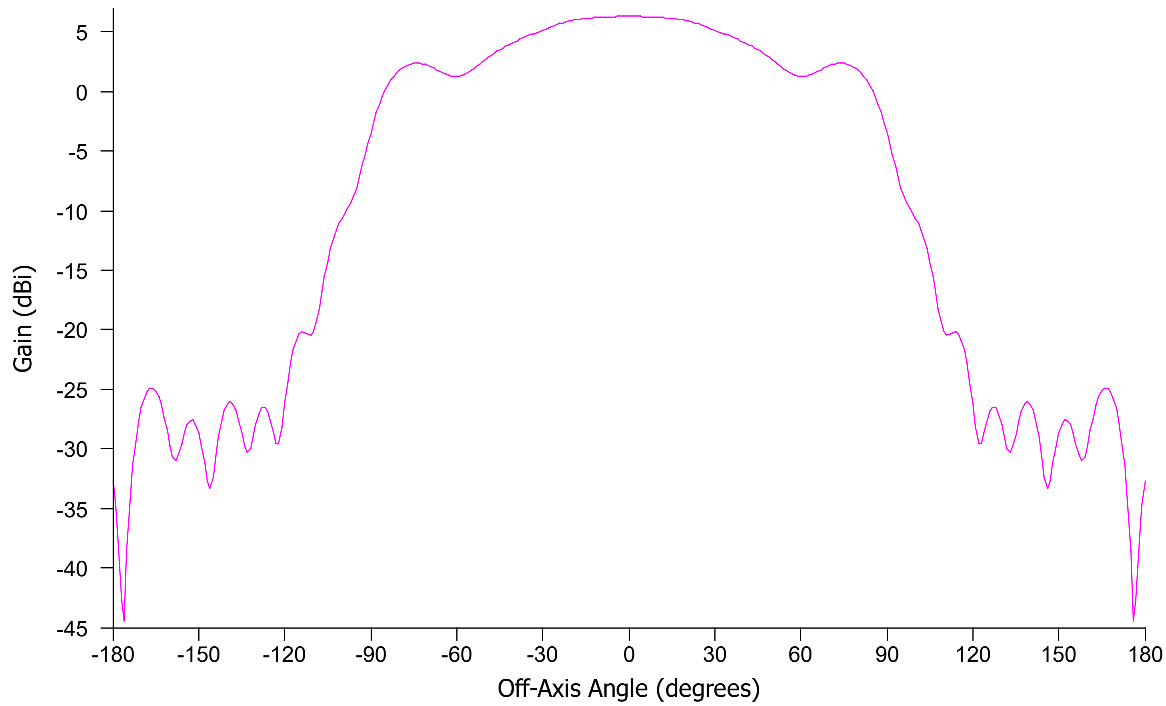


Figure A.8-2: Earth-facing X-band Patch RX

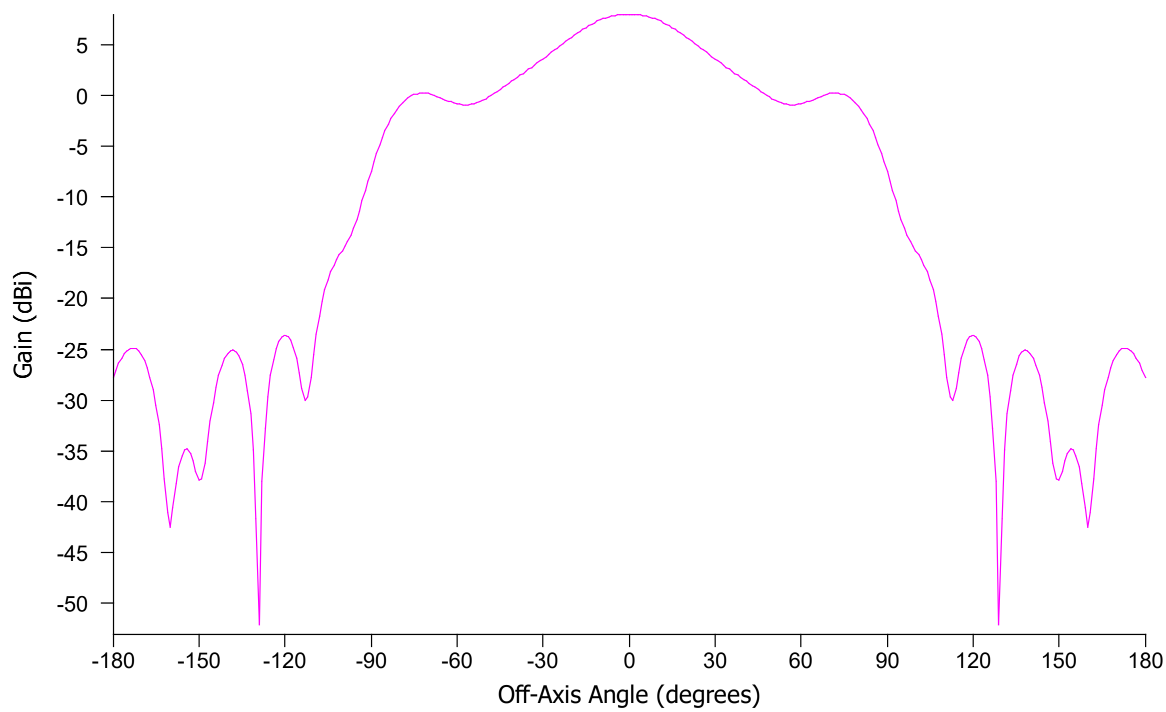


Figure A.8-3: Earth-facing 0.7m X-/Ka-band HGA, X-band TX

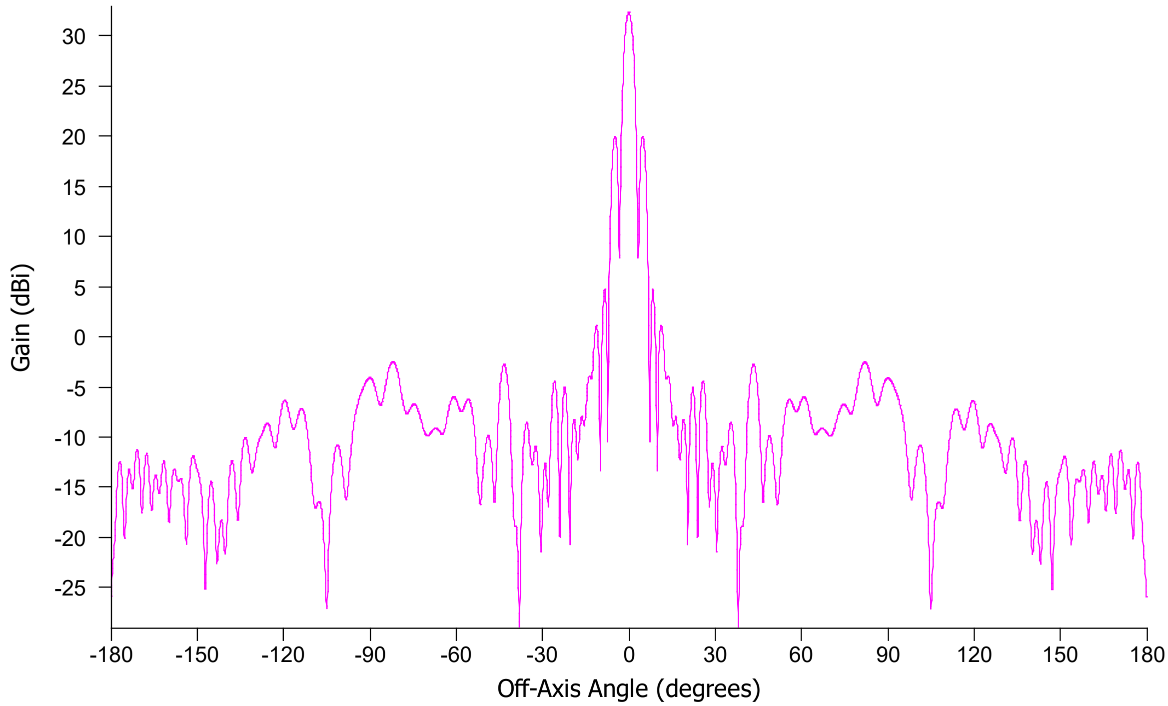


Figure A.8-4: Earth-facing 0.7m X-/Ka-band HGA, X-band RX

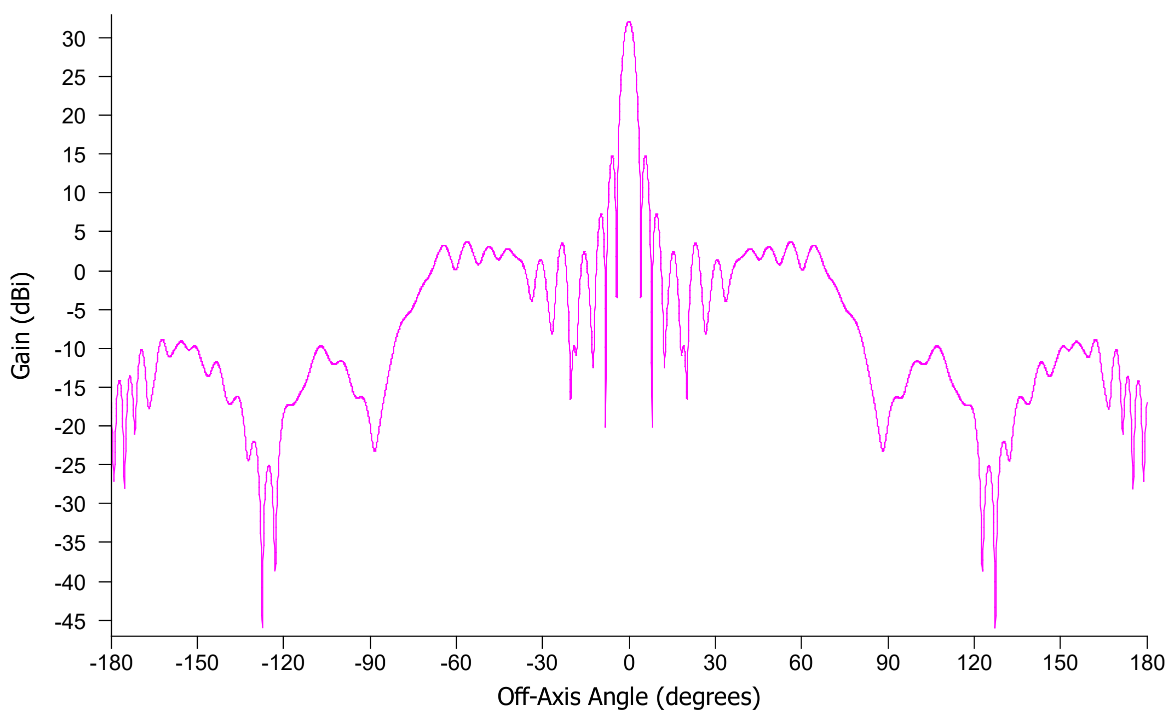


Figure A.8-5: Lunar-facing 1.25m S-/Ka-band HGA, S-band TX

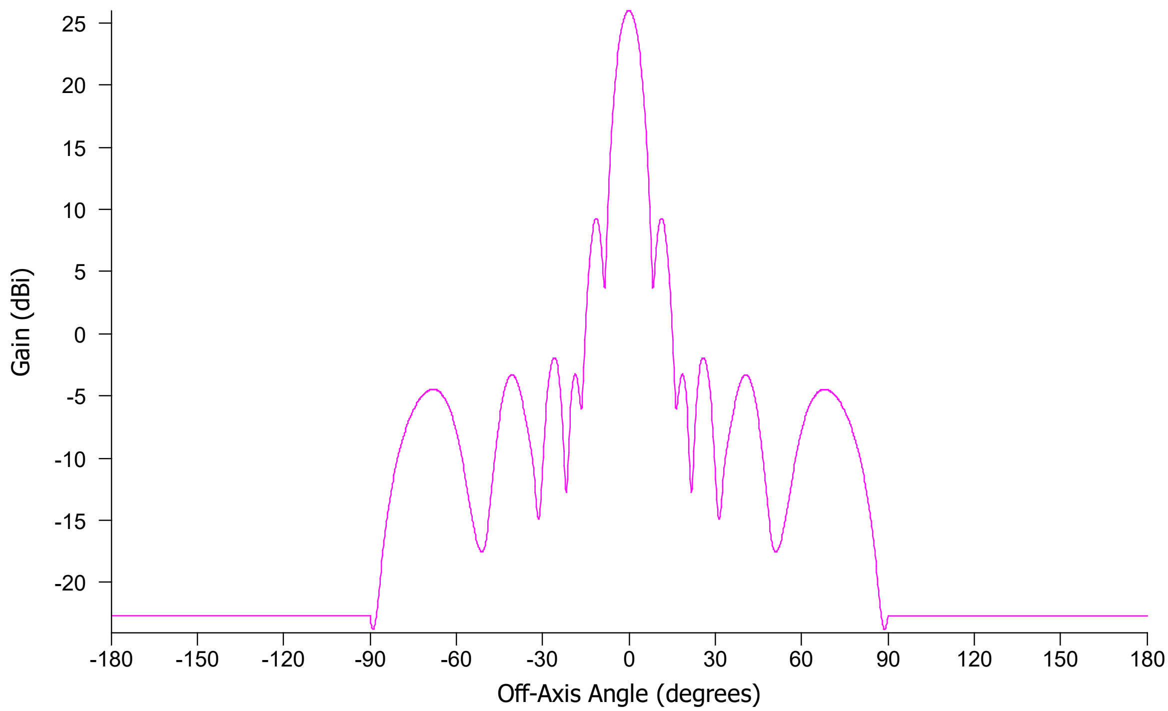


Figure A-8.6: Lunar-facing 1.25m S-/Ka-band HGA, S-band RX

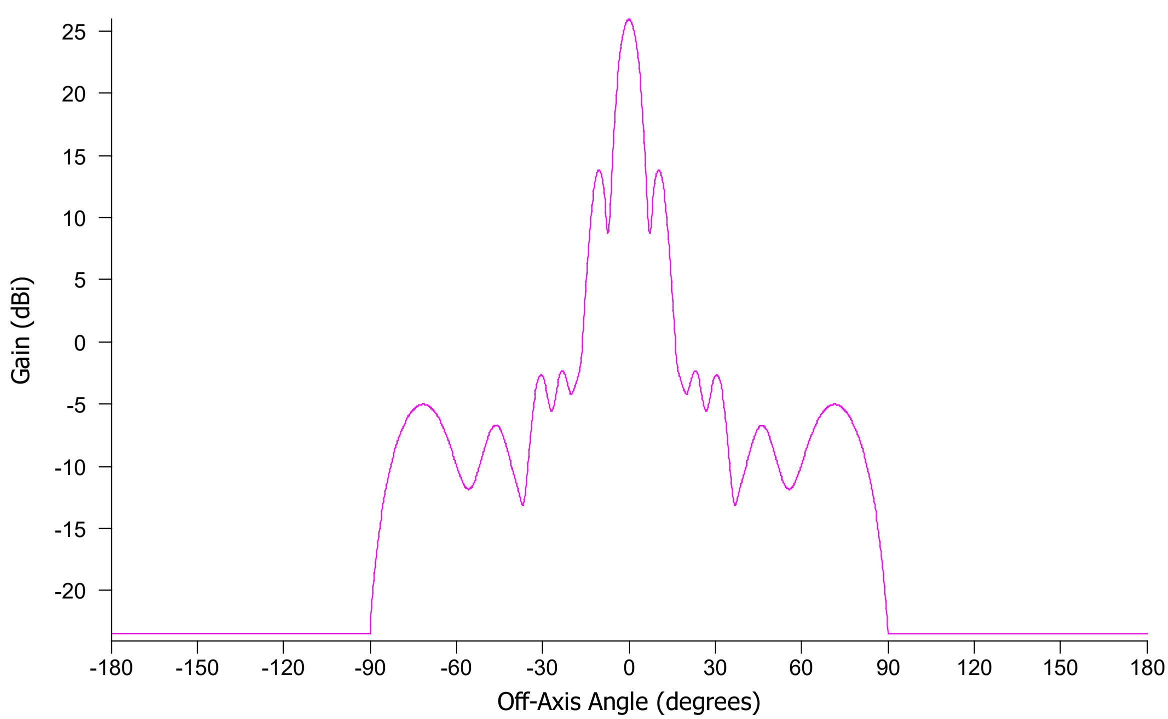


Figure A-8.7: Lunar-facing 1.25m S-/Ka-band HGA, Ka-band TX

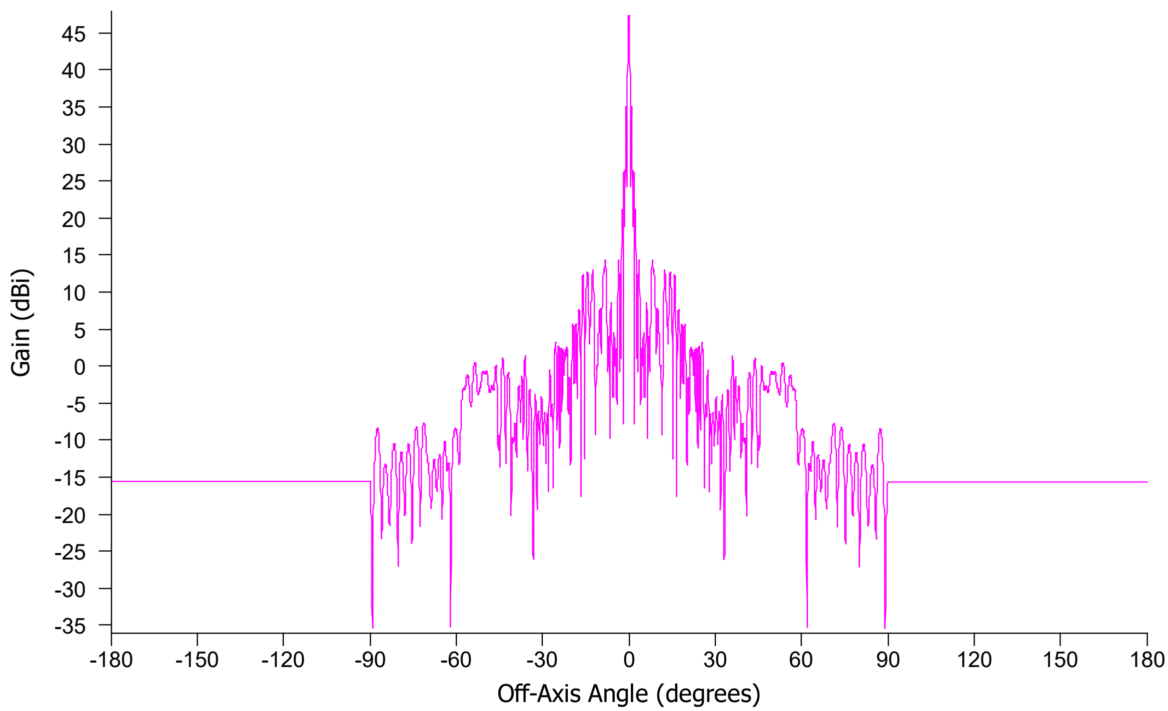


Figure A-8.8: Lunar-facing 1.25m S-/Ka-band HGA, Ka-band RX

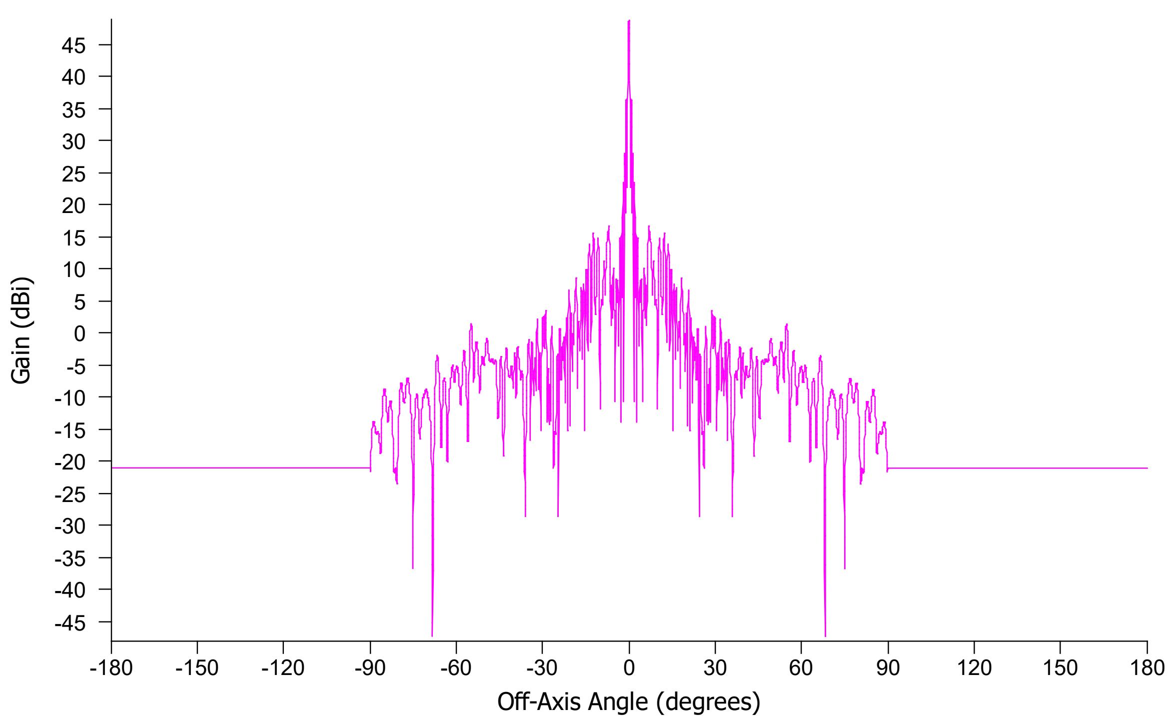


Figure A-8.9: Earth-facing 0.7m X-/Ka-band HGA, Ka-band TX

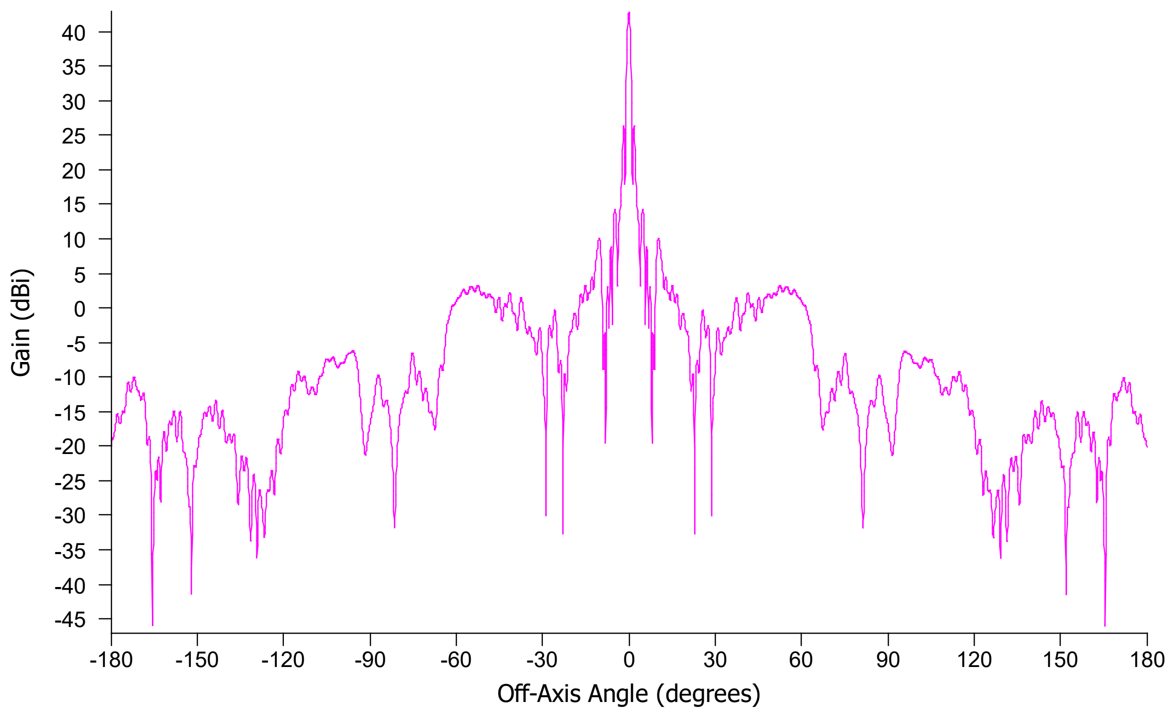


Figure A-8.10: Earth-facing 0.7m X-/Ka-band HGA, Ka-band RX

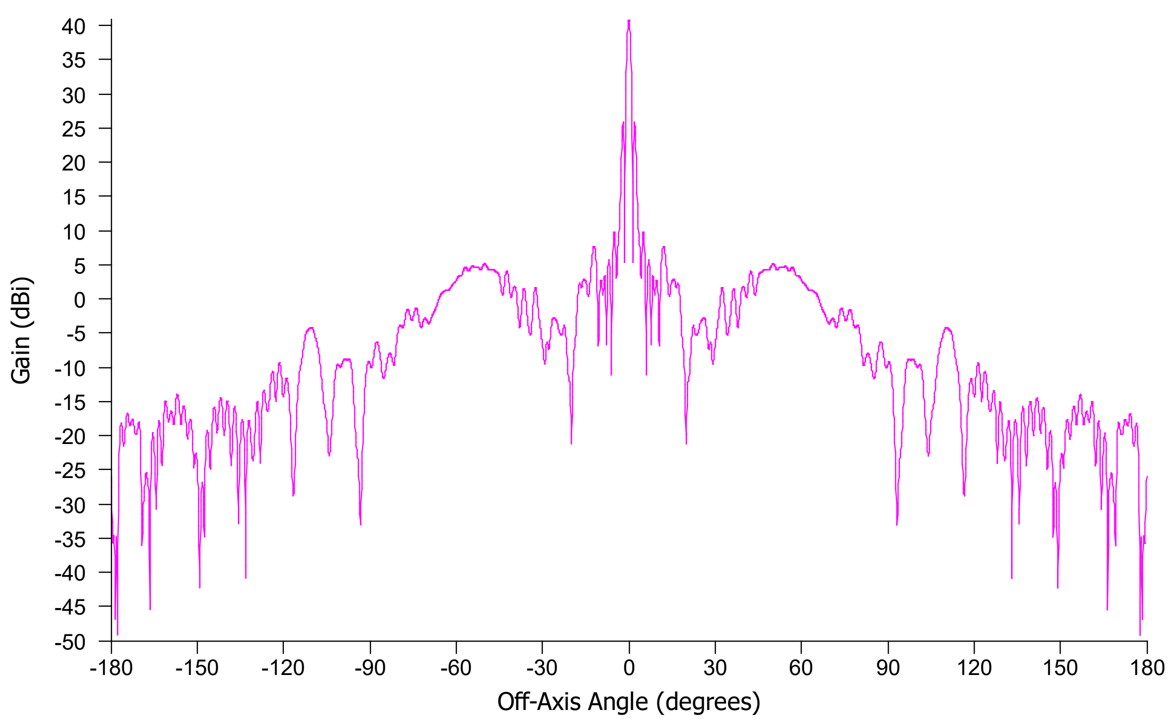


Figure A-8.11: Earth-facing AFS TX

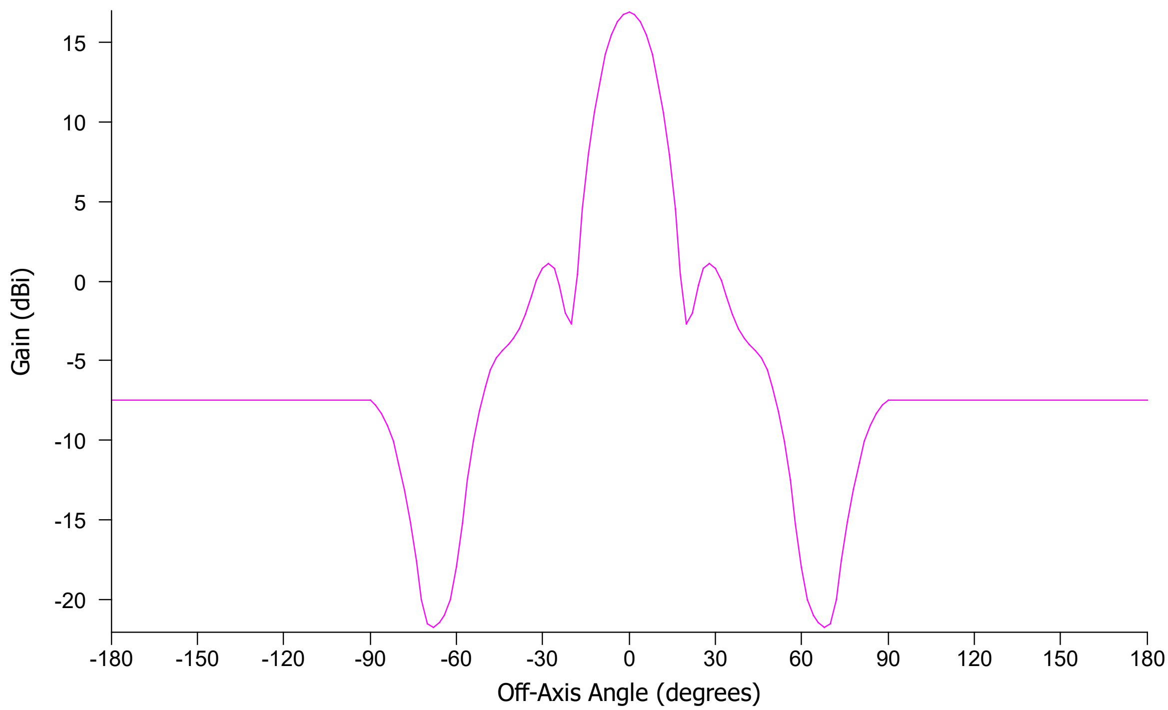


Figure A-8.12: Earth-facing AFS RX

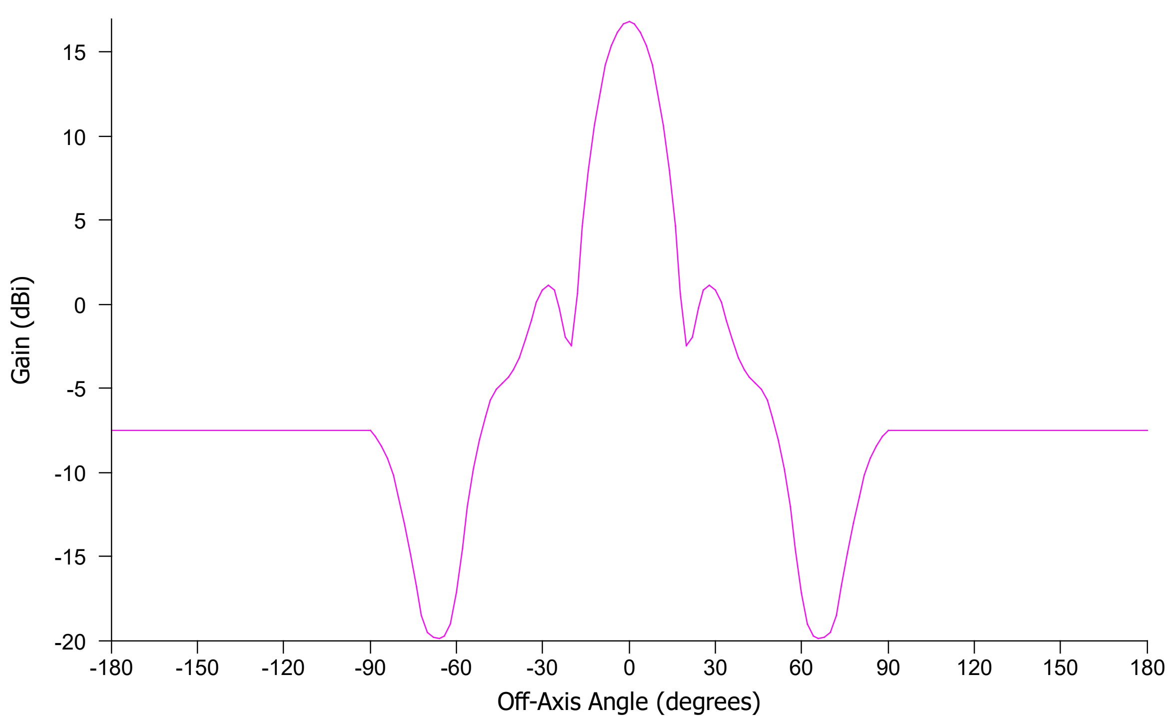
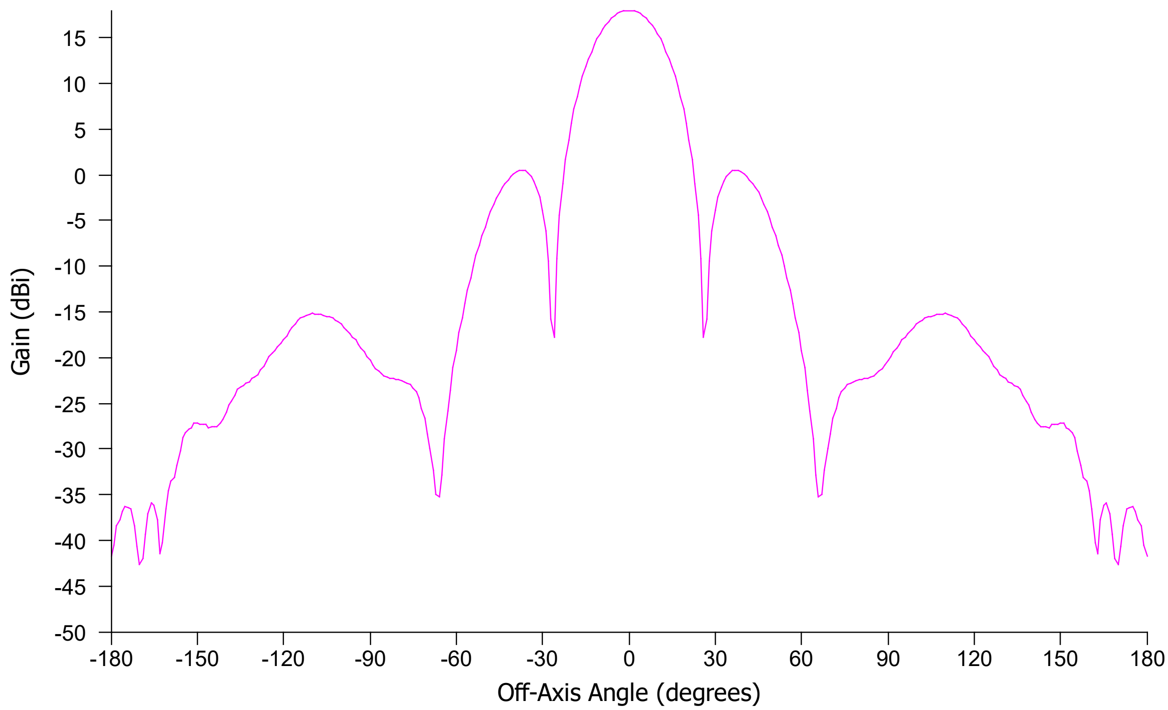


Figure A-8.13: GNSS RX



Representative contours of the X- and Ka-band antenna beams, centered over the U.S., are provided in Figures A.8-14 through A.8-17 below.

Figure A.8-14: Gain Contour Plot at Lunar Distance for the X-Band Transmit Antenna

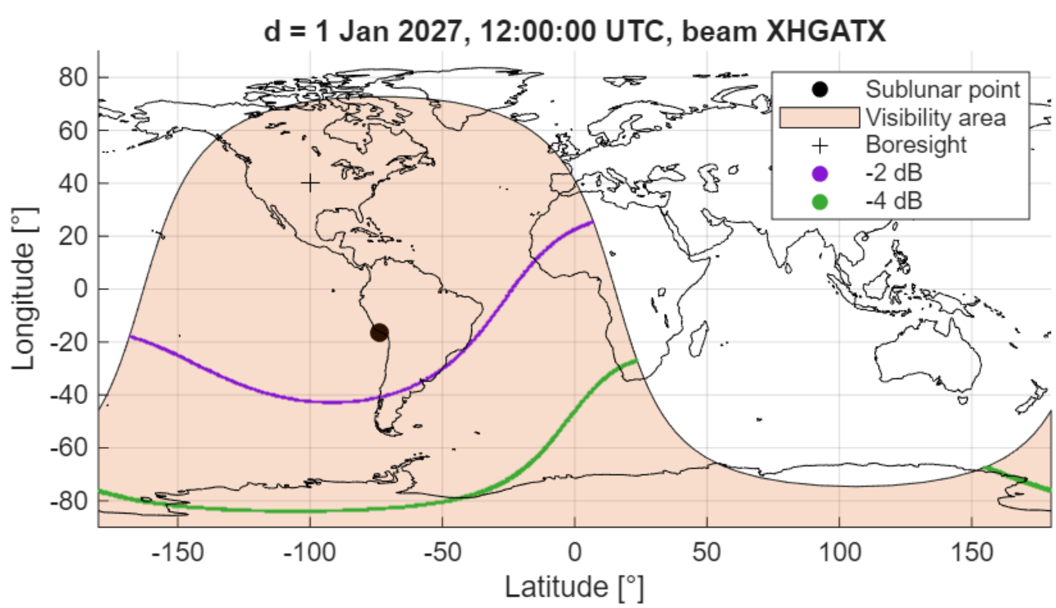


Figure A.8-15: Gain Contour Plot at Lunar Distance for the X-Band Receive Antenna

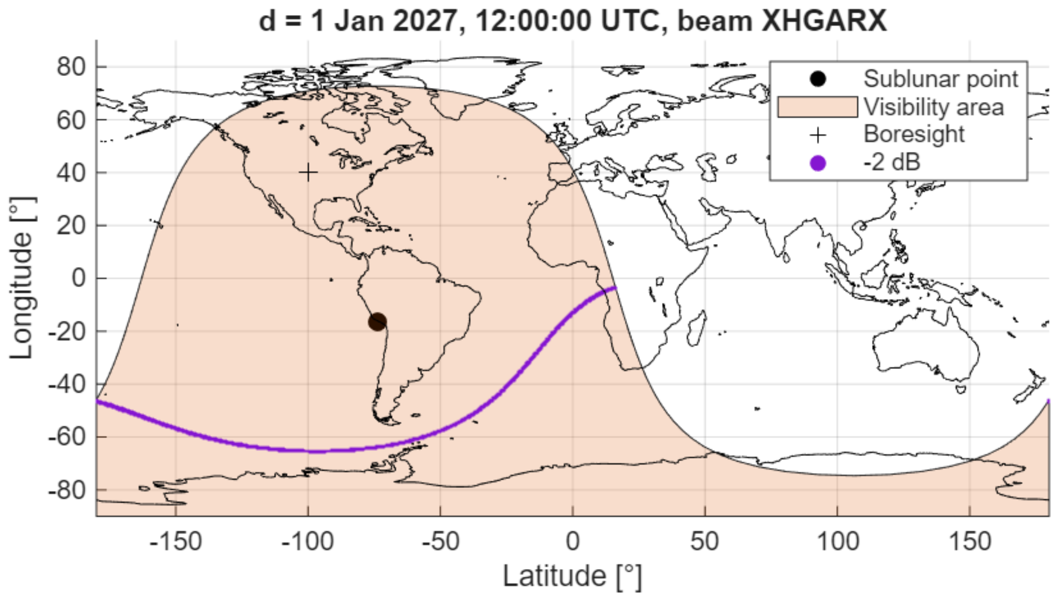


Figure A.8-16: Gain Contour Plot at Lunar Distance for the Ka-Band Transmit Antenna

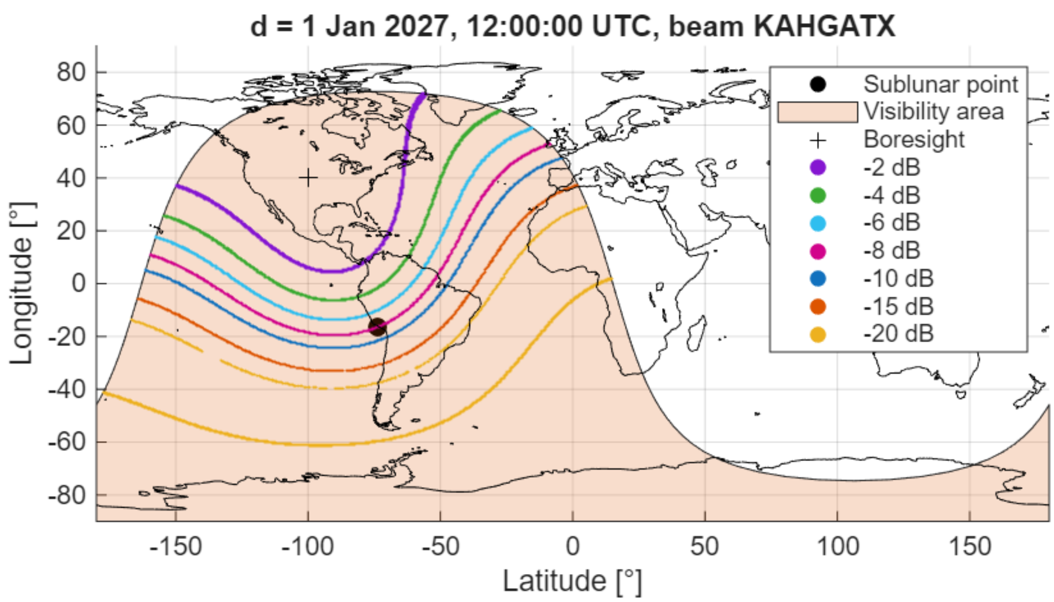
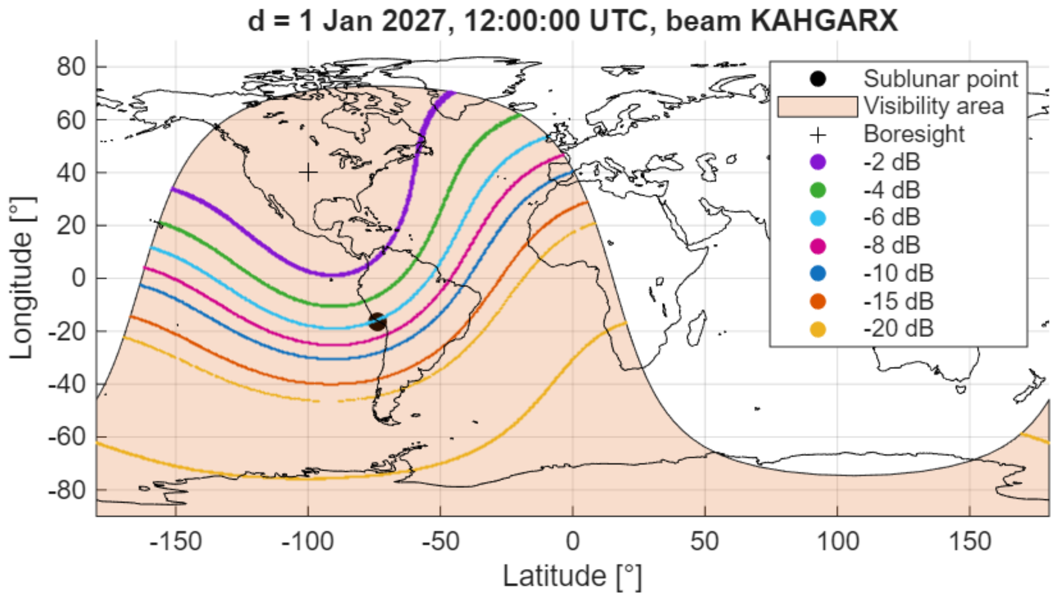


Figure A.8-17: Gain Contour Plot at Lunar Distance for the Ka-Band Receive Antenna



A.9 PAYLOADS

A.9.1 RNSS Payload

Intuitive Machines' Altus-1 satellite will host the following payloads:

Payload	Description
Raptor	Raptor Hawk 4096 is an HD video multispectral camera that Intuitive Machines purchased off the shelf. The payload consists of two parts: (1) a Hawk 4096 camera and (2) a 450mm lens. The camera's images will serve as a reference for the other on-board cameras.
CRaTER	CRaTER is a flight spare from the NASA Lunar Reconnaissance Orbiter mission. CRaTER is a radiation detector that will be used to map the lunar radiation environment to gain insight on how lunar radiation will affect future human spaceflight missions. The University of New Hampshire will transfer ownership of the payload to Intuitive Machines and will assist Intuitive Machines with processing data collected by the payload.
ScanWay	ScanWay consists of two parts: (1) a 3Dplus camera and (2) an SPO-120 lens. The payload will take images using multispectral capabilities to map lunar resources pursuant to an agreement between the European Space Agency ("ESA") and Intuitive Machines. Intuitive Machines owns the payload and will provide ESA with data to be published in ESA's Planetary Science Archive ("PSA"). All data beyond and different than what is required by ESA will be the sole property of Intuitive Machines.
Lunar HyTI	Lunar HyTI is a hyperspectral imager used to collect infrared data. The payload will be used to map lunar resources and, specifically, look for water resources on the Moon to inform future spaceflight missions. Intuitive Machines contracted with the University of Hawaii (UH) to

	develop the payload, similar to what UH previously developed for the International Space Station.
Navcube3	NavCube is a part of the NSNS contract with NASA. Goddard spaceflight will provide Intuitive Machines with the NavCube payload, which is a GNSS receiver. Intuitive Machines will provide NASA with a monthly data report and live telemetry at certain points throughout the mission. This payload's primary goal is to be used as a redundant system to aid in tracking capabilities alongside the main GNSS receivers.

A.10 EARTH STATION NETWORK

A.10.1 Earth Stations

The Altus Constellation will communicate with various earth stations during transit and while providing relay services in lunar orbit to ensure 24/7 coverage. Tables A.10-1 and A.10-2 below catalog these sites.

Table A.10-1: LTN Antenna Network

Antenna	Ground Station	Location	Size (meters)
Gateway 1	U.S. Electrodynamics Brewster Teleport	Brewster, WA USA	30
Gateway 2	Roaring Creek Earth Station (Catawissa Teleport)	Catawissa, PA USA	32
DSS17	Morehead State University Space Sciences Center	Morehead, KY USA	21
GHY-6	Goonhilly Earth Station	Cornwall, UK	32

Table A.10-2: DSN Antenna Network

Ground Station	Location	Size (meters)
Goldstone	Goldstone, CA	34
Canberra	Canberra, Australia	34
Madrid	Madrid, Spain	34

A.11 POWER FLUX DENSITY ANALYSIS AND SPECTRUM COMPATIBILITY

The Altus Constellation will not operate in any of the frequency bands or services defined in 47 C.F.R. § 25.208 (b)-(r). Furthermore, Altus satellites will not be in Earth's orbit. Therefore, the power flux density limit requirements do not apply. Intuitive Machines will coordinate with NASA and other relevant government agencies to ensure operations will not cause harmful interference.

A.12 CESSATION OF EMISSIONS

Each active spacecraft transmission chain can be individually turned on and off by ground telecommand, thereby causing cessation of emissions from the Altus Constellation, as required by Section 25.207 of the Commission's rules.

A.13 FREQUENCY TOLERANCE

The frequency tolerance requirements of Section 25.202(e) that the carrier frequency of each space station transmitter be maintained within 0.002% of the reference frequency will be met. The technical specifications for the Lucix radios indicate that for all bandwidths selected, the carrier frequency will be maintained to within +/- 100 ppb over the duration of the satellite mission.

A.14 OUT-OF-BAND EMISSIONS

The Altus satellites will comply with the Commission's rules regarding out-of-band emissions contained in Section 25.202(f).

A.15 TELEMETRY MARKER

The Altus satellites will be identifiable by a unique signal-based telemetry marker distinguishing it from other space stations or space objects consistent with Section 25.123(b)(3).

A.16 ITU FILINGS & COMPLIANCE

Intuitive Machines has prepared and filed with the International Telecommunication Union an ("ITU") Advance Publication Information ("API") submission for its proposed system, as noted in the Narrative.[12] The API information has been sent to the FCC separately under the ITU Name USA-LUNARSAT-1.

The Altus Constellation will operate in full compliance with the ITU PFD limits contained in Article 21, Table 21-4 of the ITU Radio Regulations. PFD calculations were performed for the Ka-band HGA, the X-band HGA and the X-band Patch antennas. An Altus satellite will range between approximately 360,000 and 410,000 km from Earth during its orbit. The closest distance of 360,000 km was used for the PFD calculation. Table A.16-1 below provides the maximum PFD values for the Altus Constellation.

[12] *See* Legal Narrative at Section IV.D.

Table A.16-1: ITU Article 21-4, Table 21-4 PFD Limits

Ka-band HGA – 25.5-27 GHz

Max Power Flux Density, dBW/m^2/4 kHz						
Value	**0-5**	**5-10**	**10-15**	**15-20**	**20-25**	**25-90**
PFD	-137.3	-137.3	-137.3	-137.2	-137.2	-137.1
Art. 21 Limit	-115	-112.5	-110	-107.5	-105	-105

X-band HGA – 8450-8500 MHz

Max Power Flux Density, dBW/m^2/4 kHz						
Value	**0-5**	**5-10**	**10-15**	**15-20**	**20-25**	**25-90**
PFD	-177.5	-177.5	-177.4	-177.4	-177.4	-177.3
Art. 21 Limit	-150	-147.5	-145	-142.5	-140	-140

X-band Patch – 8450-8500 MHz

Max Power Flux Density, dBW/m^2/4 kHz						
Value	**0-5**	**5-10**	**10-15**	**15-20**	**20-25**	**25-90**
PFD	-200	-200	-199.9	-199.9	-199.9	-199.8
Art. 21 Limit	-150	-147.5	-145	-142.5	-140	-140

A.17 ORBITAL DEBRIS MITIGATION[13]

Intuitive Machines provides the following information, using NASA Debris Assessment Software to perform relevant calculations, to support the Section 25.123 certifications related to orbital debris mitigation, and set forth in in the Narrative.[14] Intuitive Machines will continue to stay current with the Space Situational Awareness community and technology and, if appropriate, Intuitive Machines will modify its orbital debris mitigation protocols.

A.17.1 Mission Overview

In support of NASA's NSNS lunar relay services, Intuitive Machines is deploying the Altus Constellation to provide vital communication and navigation services for the exploration and scientific study of the Moon's South Pole region. The Altus Constellation includes services to support PNT capabilities, which are crucial for ensuring the safety of navigation on and around the lunar surface. Intuitive Machines also will enable NASA to provide communication and navigation services to customer missions in the near space region. Initially, the Altus satellites will validate

[13] *See Smallsat Order*, 34 FCC Rcd at 13107 (declining to specify a single format such as the Orbital Debris Assessment Report to provide applicants with flexibility, with the expectation that all applicants use high fidelity modeling tools to perform the calculations necessary to address the various certifications required by the Commission's rules).

[14] *See* Legal Narrative at Section II.B.2.

lunar relay capabilities and services for Artemis, including support of human landing systems, the LTV (lunar terrain vehicle), and CLPS (Commercial Lunar Payload Services) flights.

As lunar relay services become fully operational, they will be integrated into the Near Space Network's expanding portfolio, enhancing communications and navigation support for future lunar missions and reducing reliance on NASA's Deep Space Network.

A.17.2 Operational Orbital Debris

The Altus satellite is delivered to orbit via a SpaceX Falcon 9 rocket on a standard 24" diameter port of an ESPA Grande payload adapter ring. The satellite is deployed in a direction perpendicular to the launch vehicle longitudinal axis by means of a 24" diameter SEOPS Keystone separation band. The quick-release Keystone band includes 18 permanently retained separation springs that impart a uniform separation velocity to the Altus satellite with minimal tipoff. No other mechanism will be deployed from the Altus satellites, and no release of any operational debris is contemplated while the satellites orbit the Moon.

A.17.3 Orbital Debris Generated from Accidental Explosion

NASA's DAS does not provide a quantitative probability for accidental explosion. However, based on the Failure Mode and Effects Analysis ("FMEA") conducted by Intuitive Machines for battery and propulsion system explosion, there is no credible scenario that would result in spacecraft breakup during normal deployment and operations. The FMEA evaluated risks associated with battery overcharge, short circuiting and high temperatures as well as risks associated with over pressurization and valve, ignition and other material failures of the propulsion system, concluding that the expected probability of explosion for all credible failure modes of the Altus Constellation is less than 0.001.

A.17.4 Large Object Collision Probability

The large object impact and debris generation probability was calculated by DAS at 1.1537E-07 (Status = Pass), based upon the worst-case scenario where the Altus satellites are launched into a trans-lunar orbit and must passively deorbit into the atmosphere due to failures**.**

Upon receipt of a space situational awareness conjunction warning, Intuitive Machines will review conjunction warnings, coordinate physical operations of the Altus satellites with any operator using similar orbits, and, if necessary, mitigate collision risks to minimize operational impacts.

A.17.5 Design for Post-Mission Passivation and Disposal

At the start of each Altus satellite's Post-Mission Disposal Phase, Intuitive Machines will identify specific lunar craters, including a primary and backup lunar crater, into which the vehicle can be safely disposed. Crater selection criteria will focus on safety and responsibility, including crater size (large craters relative to the vehicle's surface region targeting capability), NASA Planetary Protection constraints (far from heritage sites and permanently shadowed regions), far from areas of high scientific interest (unique soil composition or surface resources), and far from areas of active human/robotic assets (Artemis or other active lunar surface missions). Craters on the Earth-facing side of the Moon will be preferred to facilitate tracking the Altus satellite along its disposal trajectory.

A disposal trajectory will then be designed from the Altus orbit to the nearest identified crater. Intuitive Machines will coordinate with NASA JPL MADCAP to perform conjunction analysis on the disposal trajectory and ensure the safety of all lunar-orbiting vehicles. A disposal maneuver will then be performed to place the Altus satellite on the designed trajectory to the selected lunar crater. Intuitive Machines will track the vehicle to impact and estimate its impact location via orbit determination. Intuitive Machines will also coordinate with lunar imaging missions such as NASA's Lunar Reconnaissance Orbiter ("LRO") to image the estimated impact site and positively confirm a successful disposal.

A.18 REMOTE SENSING CAPABILITIES

The Altus satellite involved in the instant mission includes the following cameras or optical instruments identified in Table A.18-1.

Table A.18-1: Optical Instrument Inventory

Device	No. of Units	Description
Raptor (see Section A.9.1)	1	Raptor Hawk 4096 is an HD video multispectral camera that Intuitive Machines purchased off the shelf. The payload consists of two parts: (1) a Hawk 4096 camera and (2) a 450mm lens. The camera's images will serve as a reference for the other on-board cameras.
ScanWay (see Section A.9.1)	1	ScanWay consists of two parts: (1) a 3Dplus camera and (2) a SPO-120 lens. Pursuant to an agreement between Intuitive Machines and ESA, the payload will take images using multispectral capabilities to map lunar resources. Intuitive Machines owns the payload and will provide a subset of data to ESA that will be published in ESA's PSA. All data beyond and different than what is required by ESA will be the sole property of Intuitive Machines.

Certain cameras referenced above may inadvertently capture images of the Earth while the Altus-1 satellite takes photographs of itself or its lunar environment. Such images do not contain data that can be enhanced to show topographical features on Earth, and Intuitive Machines is not making them available for sale. Such images with a distant and removed Earth in the far background may be used for marketing purposes, but they have no other meaningful utility. No camera involved in the instant mission is intended to image the Earth.

Intuitive Machines will separately submit a request to the National Oceanic and Atmospheric Administration's ("NOAA") Commercial Remote Sensing Regulatory Affairs ("CRSRA") to reaffirm that no camera involved in the instant mission qualifies as an Earth imaging instrument under 15 C.F.R. § 960.

A.19 NASA Planetary Protection Submission

Intuitive Machines has inventoried all organic materials on the Altus satellites and will make a separate submission to NASA's Planetary Protection Office to ensure compliance with NASA NID 8715.129 concerning robotic extraterrestrial missions to the lunar surface.

A.20 Schedule S Apogee & Perigee Tolerance Clarification

The apogee tolerance in field S3.g.(viii) should reflect +/- 600 km for all five proposed spacecraft. Similarly, the perigee tolerance in field S3.g.(ix) should reflect +/- 600 km for all proposed spacecraft.

This adjustment applies to all orbital planes. The numeral zero occupying each individual entry for both fields serves as a placeholder only, and does not reflect actual apogee or perigee tolerances.[15]

[15] The current Schedule S user interface would not accept numerical entries other than zero in the aforementioned fields without triggering errors that prevent validation and submission of the Schedule S.

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/ Jason Soloff

Jason Soloff
Chief Engineer
Intuitive Machines, LLC