



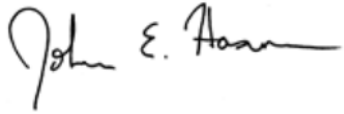
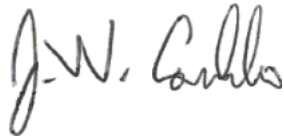
Gravitational Reference Advanced Technology Test in Space

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Prepared by:

Name	Company	Signature
Anh N. Nguyen	CrossTrac	

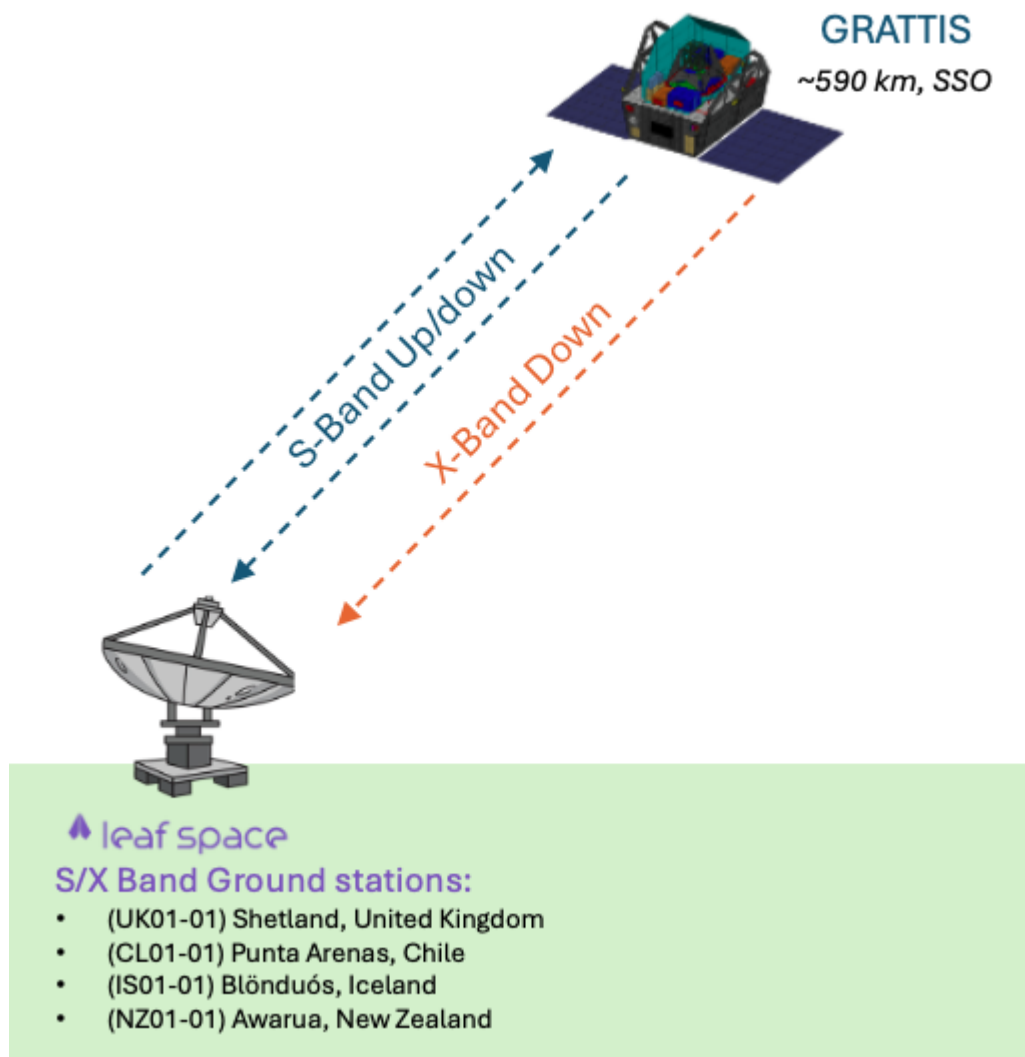
Approved by:

Name	Company	Signature
John Hanson <i>GRATTIS Project Manager</i>	CrossTrac	
John Conklin <i>GRATTIS Principal Investigator</i>	University of Florida	

Purpose

NTIA requires the following data for space related experiments using government shared spectrum. For each transmit frequency, provide the data for both ends of the transmit-receive link. Use Part A to describe the satellite to ground information. Part B is for all ground to space transmit links.

Reference: Below is an image that summarizes the comm links defined in this document. GRATTIS will be utilizing Leaf Space commercial ground stations. Note: the S/X band antenna are identical at each Ground station location.



Part A: Space to Earth Downlink Data

Satellite Transmitter Data (Required for Each Frequency)

Transmit Frequency: S-Band		
Center Frequency: 2250.0 MHz		
Satellite Name: GRATTIS		
Data Field	Data Answer	Description/Comments
Transmit Power (PWR)	PWR = 1.585 W	TRANSMIT POWER SUPPLIED TO THE ANTENNA INPUT TERMINAL, EXAMPLE, PWR01 W2 TRANSMIT POWER UNITS INCLUDE: W = WATT, K = KILOWATT, M = MEGAWATT
Necessary Bandwidth	600 kHz	THE WIDTH OF FREQUENCY BAND WHICH IS JUST SUFFICIENT TO SUCCESSFULLY TRANSFER DATA. FORMULAS CAN BE FOUND IN ANNEX J OF THE NTIA MANUAL.
RF Emissions Data		2-SIDED EMISSION BANDWIDTH VALUES
-3 dB bandwidth	276.5	
-20 dB bandwidth	579.8	
-40 dB bandwidth	1208.2	
-60 dB bandwidth	2883.8	
Modulation Type	QPSK	THE METHOD USED TO SUPERIMPOSE DATA ON THE CARRIER, EXAMPLE, BPSK, QPSK, GMSK.
Data Rate	960 kbps	INFORMATION DATA RATE
Forward Error Correction Coding	Is FEC used? Yes ☒ No ☐ FEC Type: <u>Reed-Solomon</u>, <u>Convolutional Coding ½</u>	

Transmit Frequency: S-Band		
Center Frequency: 2250.0 MHz		
Total Symbol Rate	4801 kSps	DATA RATE COMBINED WITH FEC AND FRAME OVERHEAD RESULTING IN THE TOTAL SYMBOL RATE AT THE INPUT TO THE SYMBOL MAPPER/MODULATOR.
Does transmitter have a beacon mode?	Yes ☐ No ☒	BEACON MODE IS NORMALLY CONSIDERED A REGULAR AND PERIODIC SHORT DURATION TRANSMISSION THAT IS OFTEN USED TO ASSIST WITH TRACKING, DOPPLER COMPENSATION, OR SMALL SATELLITE IDENTIFICATION WHOSE TRANSMISSIONS ARE NOT LIMITED TO DURATIONS WHEN SUPPORTING GROUND STATIONS ARE VISIBLE.
If transmitter has a beacon mode, can the beacon be commanded off?	N/A	
Transmit Antenna Polarization (XAP)	XAP = R	POLARIZATIONS INCLUDE: H = HORIZONTAL, V = VERTICAL, S = HORIZONTAL AND VERTICAL, L = LEFT HAND CIRCULAR, R = RIGHT HAND CIRCULAR, T = RIGHT AND LEFT HAND CIRCULAR, J = LINEAR POLARIZATION
Transmit Antenna Orientation (XAZ)	XAZ = NB	NB= NARROWBEAM EC = EARTH COVERAGE
Transmit Antenna Dimension (XAD)	ANTENNA GAIN: <u>4.4 dBi</u> BEAMWIDTH <u>60 deg</u> , XAD = 4G460B	NTIA FORMAT (XAD), EXAMPLE, FOR 16 DBI ANTENNA GAIN AND 30 DEGREE BEAMWIDTH XAD01 16G030B

Transmit Frequency: S-Band Center Frequency: 2250.0 MHz		
Type of satellite (State = SPCE) (City = Geo or Nongeo)	Type = NON GEOSTATIONARY	CHOOSE EITHER: GEOSTATIONARY OR NONGEOSTATIONARY
For Geostationary Satellites	Longitude = N/A	IF ANY SATELLITES ARE GEOSTATIONARY, REPORT ITS LATITUDE AS 000000N (XLA AND/OR RLA) AND REPORT ITS LONGITUDE IN DDDMMSS FORMAT (XLG AND/OR RLG).
For Nongeostationary (Orbital Data)	INCLINATION ANGLE: <u>97.6 DEG</u> , APOGEE IN KILOMETERS: <u>550 KM</u> , PERIGEE IN KILOMETERS: <u>550 KM</u> , ORBITAL PERIOD IN HOURS: <u>1</u> AND FRACTIONS OF HOURS IN DECIMAL: <u>0.6</u> , THE NUMBER OF SATELLITES IN THE SYSTEM: <u>1</u> , ORB = *ORB,97.6IN00550AP00550PE001.6H01NRT01	IF ANY SATELLITES ARE NONGEOSTATIONARY, REPORT ITS INCLINATION ANGLE, APOGEE IN KILOMETERS, PERIGEE IN KILOMETERS, ORBITAL PERIOD IN HOURS AND FRACTIONS OF HOURS IN DECIMAL, THE NUMBER OF SATELLITES IN THE SYSTEM, THEN T01, EXAMPLE, REM04 *ORB,98.0IN00510AP00510PE001.58H01NRT01 , AND FOR SPACE-TO-SPACE COMMUNICATIONS WITH ANOTHER NONGEOSTATIONARY SATELLITE ADD AN ADDITIONAL *ORB FOR IT ENDING IN R01, EXAMPLE, REM05 *ORB,72.9IN03209AP00655PE013.46H01NRR01
For SunSynchronous Nongeostationary Orbits	Mean Local Time of Ascending Node (MLTAN) = <u>22:30</u>	MLTAN IS THE ANGLE BETWEEN AN ORBIT'S ASCENDING NODE AND THE MEAN SUN, OFTEN EXPRESSED AS UNIT OF TIME (HH:MM)

Transmit Frequency: X-Band		
Center Frequency: 8212.5 MHz		
Satellite Name: GRATTIS		
Data Field	Data Answer	Description/Comments
Transmit Power (PWR)	PWR = 1.585 W	TRANSMIT POWER SUPPLIED TO THE ANTENNA INPUT TERMINAL, EXAMPLE, PWR01 W2 TRANSMIT POWER UNITS INCLUDE: W = WATT, K = KILOWATT, M = MEGAWATT
Necessary Bandwidth	38400 kHz	THE WIDTH OF FREQUENCY BAND WHICH IS JUST SUFFICIENT TO SUCCESSFULLY TRANSFER DATA. FORMULAS CAN BE FOUND IN ANNEX J OF THE NTIA MANUAL.
RF Emissions Data		2-SIDED EMISSION BANDWIDTH VALUES
-3 dB bandwidth	35467	
-20 dB bandwidth	45115	
-40 dB bandwidth	117291	
-60 dB bandwidth	213443	
Modulation Type	QPSK, 8PSK, 16APSK, 32APSK	THE METHOD USED TO SUPERIMPOSE DATA ON THE CARRIER, EXAMPLE, BPSK, QPSK, GMSK.
Data Rate	61440 kbps	INFORMATION DATA RATE
Forward Error Correction Coding	Is FEC used? Yes ☒ No ☐ FEC Type: <u>LDPC/BCH</u> FEC Rate:	

Transmit Frequency: X-Band		
Center Frequency: 8212.5 MHz		
Total Symbol Rate	30720 kSps	DATA RATE COMBINED WITH FEC AND FRAME OVERHEAD RESULTING IN THE TOTAL SYMBOL RATE AT THE INPUT TO THE SYMBOL MAPPER/MODULATOR.
Does transmitter have a beacon mode?	Yes ☐ No ☒	BEACON MODE IS NORMALLY CONSIDERED A REGULAR AND PERIODIC SHORT DURATION TRANSMISSION THAT IS OFTEN USED TO ASSIST WITH TRACKING, DOPPLER COMPENSATION, OR SMALL SATELLITE IDENTIFICATION WHOSE TRANSMISSIONS ARE NOT LIMITED TO DURATIONS WHEN SUPPORTING GROUND STATIONS ARE VISIBLE.
If transmitter has a beacon mode, can the beacon be commanded off?	N/A	
Transmit Antenna Polarization (XAP)	XAP = R	POLARIZATIONS INCLUDE: H = HORIZONTAL, V = VERTICAL, S = HORIZONTAL AND VERTICAL, L = LEFT HAND CIRCULAR, R = RIGHT HAND CIRCULAR, T = RIGHT AND LEFT HAND CIRCULAR, J = LINEAR POLARIZATION
Transmit Antenna Orientation (XAZ)	XAZ = NB	NB= NARROWBEAM EC = EARTH COVERAGE
Transmit Antenna Dimension (XAD)	ANTENNA GAIN: <u>16.6 dBi</u> BEAMWIDTH <u>24 deg</u> , XAD = 16G624B	NTIA FORMAT (XAD), EXAMPLE, FOR 16 DBI ANTENNA GAIN AND 30 DEGREE BEAMWIDTH XAD01 16G030B

Transmit Frequency: X-Band <i>Center Frequency: 8212.5 MHz</i>		
Type of satellite (State = SPCE) (City = Geo or Nongeo)	Type = NON GEOSTATIONARY	CHOOSE EITHER: GEOSTATIONARY OR NONGEOSTATIONARY
For Geostationary Satellites	Longitude = N/A	IF ANY SATELLITES ARE GEOSTATIONARY, REPORT ITS LATITUDE AS 000000N (XLA AND/OR RLA) AND REPORT ITS LONGITUDE IN DDDMMSS FORMAT (XLG AND/OR RLG).
For Nongeostationary (Orbital Data)	INCLINATION ANGLE: <u>97.6 DEG</u> , APOGEE IN KILOMETERS: <u>550</u> <u>KM</u> , PERIGEE IN KILOMETERS: <u>550 KM</u> , ORBITAL PERIOD IN HOURS: <u>1</u> AND FRACTIONS OF HOURS IN DECIMAL: <u>0.6</u> , THE NUMBER OF SATELLITES IN THE SYSTEM: <u>1</u> , ORB = *ORB,97.6IN00550AP00550PE001.6 H01NRT01	IF ANY SATELLITES ARE NONGEOSTATIONARY, REPORT ITS INCLINATION ANGLE, APOGEE IN KILOMETERS, PERIGEE IN KILOMETERS, ORBITAL PERIOD IN HOURS AND FRACTIONS OF HOURS IN DECIMAL, THE NUMBER OF SATELLITES IN THE SYSTEM, THEN T01, EXAMPLE, REM04 *ORB,98.0IN00510AP00510PE001.58H01NRT01 , AND FOR SPACE-TO-SPACE COMMUNICATIONS WITH ANOTHER NONGEOSTATIONARY SATELLITE ADD AN ADDITIONAL *ORB FOR IT ENDING IN R01, EXAMPLE, REM05 *ORB,72.9IN03209AP00655PE013.46H01NRR0 1
For SunSynchronous Nongeostationary Orbits	Mean Local Time of Ascending Node (MLTAN) = <u>22:30</u>	MLTAN IS THE ANGLE BETWEEN AN ORBIT'S ASCENDING NODE AND THE MEAN SUN, OFTEN EXPRESSED AS UNIT OF TIME (HH:MM)

Earth Station Data (Receiver) at Each Earth Station Location

S- Band [Shetland, UK]		
State (RSC)	RSC = United Kingdom	
City Name (RAL)	RAL = Shetland	
Latitude (DDMMSS)	Lat = 604454N	
Longitude (DDDMMSS)	Lon = 005130W	
Receive Antenna Polarization (RAP)	RAP = T	POLARIZATIONS INCLUDE: H = HORIZONTAL, V = VERTICAL, S = HORIZONTAL AND VERTICAL, L = LEFT HAND CIRCULAR, R = RIGHT HAND CIRCULAR, T = RIGHT AND LEFT HAND CIRCULAR, J = LINEAR POLARIZATION
Receive Antenna Orientation (RAZ)	RAZ = V00 <i>(Az: 0 deg to 360 deg)</i>	THE EARTH STATION RECEIVER ANTENNA MINIMUM OPERATING ANGLE OF ELEVATION (RAZ), V00 TO V90, EXAMPLE, RAZ01 V00

S- Band [Shetland, UK]		
Receive Antenna Dimensions (RAD)	ANTENNA GAIN: <u>35 DBi</u> , BEAMWIDTH: <u>2.76 deg</u> , AZIMUTHAL RANGE: <u>000-360</u> , THE SITE ELEVATION ABOVE MEAN SEA LEVEL IN METERS <u>19 m</u> , THE ANTENNA HEIGHT ABOVE TERRAIN IN METERS <u>2.2m</u> , RAD = 35G003B001-360A00019H002	EXAMPLE ASSUMING NONGEOSTATIONARY, 16 DBI GAIN, 30 DEGREE BEAMWIDTH, AZIMUTHAL RANGE FROM 001-360, SITE ELEVATION OF 357 METERS, AND ANTENNA HEIGHT ABOVE TERRAIN OF 6 METERS: RAD01 16G030B001-360A00357H006
Receive Antenna Additional Information (For Parabolic Antennas)	ANTENNA DIAMETER: <u>3.7m</u> , ANTENNA EFFICIENCY: <u>0.55</u> ,	
Number of Satellite Contacts Supported Per Day	1	NUMBER OF TIMES THE SATELLITE WILL COMMUNICATE WITH THE EARTH STATION IN THE SPACE TO EARTH DIRECTION (DOWNLINKS) EACH DAY
Expected Duration of Each Contact	<u>7 min</u>	AVERAGE DURATION OF EACH CONTACT
Supported Operations	Satellite Health and Status Data ☒ Mission Payload Data ☒	SATELLITE HEALTH AND STATUS TELEMETRY AND/OR MISSION PAYLOAD DATA
FCC notes:		

X- Band [Shetland, UK]		
State (RSC)	RSC = United Kingdom	
City Name (RAL)	RAL = Shetland	
Latitude (DDMMSS)	Lat = 604454N	

X- Band [Shetland, UK]		
Longitude (DDMMSS)	Lon = 005130W	
Receive Antenna Polarization (RAP)	RAP = T	POLARIZATIONS INCLUDE: H = HORIZONTAL, V = VERTICAL, S = HORIZONTAL AND VERTICAL, L = LEFT HAND CIRCULAR, R = RIGHT HAND CIRCULAR, T = RIGHT AND LEFT HAND CIRCULAR, J = LINEAR POLARIZATION
Receive Antenna Orientation (RAZ)	RAZ = V00 <i>(Az: 0 deg to 360 deg)</i>	THE EARTH STATION RECEIVER ANTENNA MINIMUM OPERATING ANGLE OF ELEVATION (RAZ), V00 TO V90, EXAMPLE, RAZ01 V00
Receive Antenna Dimensions (RAD)	ANTENNA GAIN: <u>35 DBi</u> , BEAMWIDTH: <u>0.6 deg</u> , AZIMUTHAL RANGE: <u>000-360</u> , THE SITE ELEVATION ABOVE MEAN SEA LEVEL IN METERS <u>19 m</u> , THE ANTENNA HEIGHT ABOVE TERRAIN IN METERS <u>2.2m</u> , RAD = 35G001B001-360A00019H002	EXAMPLE ASSUMING NONGEOSTATIONARY, 16 DBI GAIN, 30 DEGREE BEAMWIDTH, AZIMUTHAL RANGE FROM 001-360, SITE ELEVATION OF 357 METERS, AND ANTENNA HEIGHT ABOVE TERRAIN OF 6 METERS: RAD01 16G030B001-360A00357H006
Receive Antenna Additional Information (For Parabolic Antennas)	ANTENNA DIAMETER: <u>3.7m</u> , ANTENNA EFFICIENCY: <u>0.55</u> ,	

X- Band [Shetland, UK]		
Number of Satellite Contacts Supported Per Day	1	NUMBER OF TIMES THE SATELLITE WILL COMMUNICATE WITH THE EARTH STATION IN THE SPACE TO EARTH DIRECTION (DOWNLINKS) EACH DAY
Expected Duration of Each Contact	<u>7 min</u>	AVERAGE DURATION OF EACH CONTACT
Supported Operations	Satellite Health and Status Data ☒ Mission Payload Data ☒	SATELLITE HEALTH AND STATUS TELEMETRY AND/OR MISSION PAYLOAD DATA
FCC notes:		

S- Band [Chile, Punta Arenas]		
State (RSC)	RSC = Chile	
City Name (RAL)	RAL = Punta Arenas	
Latitude (DDMMSS)	Lat = 530230S	
Longitude (DDMMSS)	Lon = 0705049W	
Receive Antenna Polarization (RAP)	RAP = T	POLARIZATIONS INCLUDE: H = HORIZONTAL, V = VERTICAL, S = HORIZONTAL AND VERTICAL, L = LEFT HAND CIRCULAR, R = RIGHT HAND CIRCULAR, T = RIGHT AND LEFT HAND CIRCULAR, J = LINEAR POLARIZATION

S- Band [Chile, Punta Arenas]		
Receive Antenna Orientation (RAZ)	RAZ = V00 <i>(Az: 0 deg to 360 deg)</i>	THE EARTH STATION RECEIVER ANTENNA MINIMUM OPERATING ANGLE OF ELEVATION (RAZ), V00 TO V90, EXAMPLE, RAZ01 V00
Receive Antenna Dimensions (RAD)	ANTENNA GAIN: <u>35 DBi</u> , BEAMWIDTH: <u>2.76 deg</u> , AZIMUTHAL RANGE: <u>000-360</u> , THE SITE ELEVATION ABOVE MEAN SEA LEVEL IN METERS <u>36 m</u> , THE ANTENNA HEIGHT ABOVE TERRAIN IN METERS <u>3.2m</u> , RAD = 35G003B001-360A00036H003	EXAMPLE ASSUMING NONGEOSTATIONARY, 16 DBI GAIN, 30 DEGREE BEAMWIDTH, AZIMUTHAL RANGE FROM 001-360, SITE ELEVATION OF 357 METERS, AND ANTENNA HEIGHT ABOVE TERRAIN OF 6 METERS: RAD01 16G030B001-360A00357H006
Receive Antenna Additional Information (For Parabolic Antennas)	ANTENNA DIAMETER: <u>3.7m</u> , ANTENNA EFFICIENCY: <u>0.55</u> ,	
Number of Satellite Contacts Supported Per Day	1	NUMBER OF TIMES THE SATELLITE WILL COMMUNICATE WITH THE EARTH STATION IN THE SPACE TO EARTH DIRECTION (DOWNLINKS) EACH DAY
Expected Duration of Each Contact	<u>7 min</u>	AVERAGE DURATION OF EACH CONTACT
Supported Operations	Satellite Health and Status Data ☒ Mission Payload Data ☒	SATELLITE HEALTH AND STATUS TELEMETRY AND/OR MISSION PAYLOAD DATA
FCC notes:		

X- Band [Chile, Punta Arenas]		
State (RSC)	RSC = Chile	
City Name (RAL)	RAL = Punta Arenas	
Latitude (DDMMSS)	Lat = 530230S	
Longitude (DDDMMSS)	Lon = 0705049W	
Receive Antenna Polarization (RAP)	RAP = T	POLARIZATIONS INCLUDE: H = HORIZONTAL, V = VERTICAL, S = HORIZONTAL AND VERTICAL, L = LEFT HAND CIRCULAR, R = RIGHT HAND CIRCULAR, T = RIGHT AND LEFT HAND CIRCULAR, J = LINEAR POLARIZATION
Receive Antenna Orientation (RAZ)	RAZ = V00 (Az: 0 deg to 360 deg)	THE EARTH STATION RECEIVER ANTENNA MINIMUM OPERATING ANGLE OF ELEVATION (RAZ), V00 TO V90, EXAMPLE, RAZ01 V00
Receive Antenna Dimensions (RAD)	ANTENNA GAIN: <u>35 DBi</u>, BEAMWIDTH: <u>0.6 deg</u>, AZIMUTHAL RANGE: <u>000-360</u>, THE SITE ELEVATION ABOVE MEAN SEA LEVEL IN METERS <u>36 m</u>, THE ANTENNA HEIGHT ABOVE TERRAIN IN METERS <u>3.2m</u>, RAD = 35G001B001-360A00036H003	EXAMPLE ASSUMING NONGEOSTATIONARY, 16 DBI GAIN, 30 DEGREE BEAMWIDTH, AZIMUTHAL RANGE FROM 001-360, SITE ELEVATION OF 357 METERS, AND ANTENNA HEIGHT ABOVE TERRAIN OF 6 METERS: RAD01 16G030B001-360A00357H006

X- Band [Chile, Punta Arenas]		
Receive Antenna Additional Information (For Parabolic Antennas)	ANTENNA DIAMETER: <u>3.7m</u> , ANTENNA EFFICIENCY: <u>0.55</u> ,	
Number of Satellite Contacts Supported Per Day	1	NUMBER OF TIMES THE SATELLITE WILL COMMUNICATE WITH THE EARTH STATION IN THE SPACE TO EARTH DIRECTION (DOWNLINKS) EACH DAY
Expected Duration of Each Contact	<u>7 min</u>	AVERAGE DURATION OF EACH CONTACT
Supported Operations	Satellite Health and Status Data ☒ Mission Payload Data ☒	SATELLITE HEALTH AND STATUS TELEMETRY AND/OR MISSION PAYLOAD DATA
FCC notes:		

S-Band [Blönduós, Iceland]		
State (RSC)	RSC = Blönduós	
City Name (RAL)	RAL = Iceland	
Latitude (DDMMSS)	Lat = 653850N	
Longitude (DDMMSS)	Lon = 0201442W	

Receive Antenna Polarization (RAP)	RAP = T	POLARIZATIONS INCLUDE: H = HORIZONTAL, V = VERTICAL, S = HORIZONTAL AND VERTICAL, L = LEFT HAND CIRCULAR, R = RIGHT HAND CIRCULAR, T = RIGHT AND LEFT HAND CIRCULAR, J = LINEAR POLARIZATION
Receive Antenna Orientation (RAZ)	RAZ = V00 (Az: 0 deg to 360 deg)	THE EARTH STATION RECEIVER ANTENNA MINIMUM OPERATING ANGLE OF ELEVATION (RAZ), V00 TO V90, EXAMPLE, RAZ01 V00
Receive Antenna Dimensions (RAD)	ANTENNA GAIN: <u>35 DBi</u>, BEAMWIDTH: <u>2.76 deg</u>, AZIMUTHAL RANGE: <u>000-360</u>, THE SITE ELEVATION ABOVE MEAN SEA LEVEL IN METERS <u>55 m</u>, THE ANTENNA HEIGHT ABOVE TERRAIN IN METERS <u>2.5 m</u>, RAD = 35G003B001-360A00055H003	EXAMPLE ASSUMING NONGEOSTATIONARY, 16 DBI GAIN, 30 DEGREE BEAMWIDTH, AZIMUTHAL RANGE FROM 001-360, SITE ELEVATION OF 357 METERS, AND ANTENNA HEIGHT ABOVE TERRAIN OF 6 METERS: RAD01 16G030B001-360A00357H006
Receive Antenna Additional Information (For Parabolic Antennas)	ANTENNA DIAMETER: <u>3.7m</u>, ANTENNA EFFICIENCY: <u>0.55</u>,	

Number of Satellite Contacts Supported Per Day	1	NUMBER OF TIMES THE SATELLITE WILL COMMUNICATE WITH THE EARTH STATION IN THE SPACE TO EARTH DIRECTION (DOWNLINKS) EACH DAY
Expected Duration of Each Contact	<u>7 min</u>	AVERAGE DURATION OF EACH CONTACT
Supported Operations	Satellite Health and Status Data ☒ Mission Payload Data ☒	SATELLITE HEALTH AND STATUS TELEMETRY AND/OR MISSION PAYLOAD DATA
FCC notes:		

X-Band [Blönduós, Iceland]		
State (RSC)	RSC = Blönduós	
City Name (RAL)	RAL = Iceland	
Latitude (DDMMSS)	Lat = 653850N	
Longitude (DDDMMSS)	Lon = 0201442W	
Receive Antenna Polarization (RAP)	RAP = T	POLARIZATIONS INCLUDE: H = HORIZONTAL, V = VERTICAL, S = HORIZONTAL AND VERTICAL, L = LEFT HAND CIRCULAR, R = RIGHT HAND CIRCULAR, T = RIGHT AND LEFT HAND CIRCULAR, J = LINEAR POLARIZATION

Receive Antenna Orientation (RAZ)	RAZ = V00 <i>(Az: 0 deg to 360 deg)</i>	THE EARTH STATION RECEIVER ANTENNA MINIMUM OPERATING ANGLE OF ELEVATION (RAZ), V00 TO V90, EXAMPLE, RAZ01 V00
Receive Antenna Dimensions (RAD)	ANTENNA GAIN: <u>35 DBi</u> , BEAMWIDTH: <u>0.6 deg</u> , AZIMUTHAL RANGE: <u>000-360</u> , THE SITE ELEVATION ABOVE MEAN SEA LEVEL IN METERS <u>55 m</u> , THE ANTENNA HEIGHT ABOVE TERRAIN IN METERS <u>2.5 m</u> , RAD = 35G001B001-360A00055H003	EXAMPLE ASSUMING NONGEOSTATIONARY, 16 DBI GAIN, 30 DEGREE BEAMWIDTH, AZIMUTHAL RANGE FROM 001-360, SITE ELEVATION OF 357 METERS, AND ANTENNA HEIGHT ABOVE TERRAIN OF 6 METERS: RAD01 16G030B001-360A00357H006
Receive Antenna Additional Information (For Parabolic Antennas)	ANTENNA DIAMETER: <u>3.7m</u> , ANTENNA EFFICIENCY: <u>0.55</u> ,	
Number of Satellite Contacts Supported Per Day	1	NUMBER OF TIMES THE SATELLITE WILL COMMUNICATE WITH THE EARTH STATION IN THE SPACE TO EARTH DIRECTION (DOWNLINKS) EACH DAY
Expected Duration of Each Contact	<u>7 min</u>	AVERAGE DURATION OF EACH CONTACT
Supported Operations	Satellite Health and Status Data ☒ Mission Payload Data ☒	SATELLITE HEALTH AND STATUS TELEMETRY AND/OR MISSION PAYLOAD DATA
FCC notes:		

S- Band [Awarua, New Zealand]		
State (RSC)	RSC = Awarua	
City Name (RAL)	RAL = New Zealand	
Latitude (DDMMSS)	Lat = 463141S	
Longitude (DDMMSS)	Lon = 1682245W	
Receive Antenna Polarization (RAP)	RAP = T	POLARIZATIONS INCLUDE: H = HORIZONTAL, V = VERTICAL, S = HORIZONTAL AND VERTICAL, L = LEFT HAND CIRCULAR, R = RIGHT HAND CIRCULAR, T = RIGHT AND LEFT HAND CIRCULAR, J = LINEAR POLARIZATION
Receive Antenna Orientation (RAZ)	RAZ = V00 <i>(Az: 0 deg to 360 deg)</i>	THE EARTH STATION RECEIVER ANTENNA MINIMUM OPERATING ANGLE OF ELEVATION (RAZ), V00 TO V90, EXAMPLE, RAZ01 V00
Receive Antenna Dimensions (RAD)	ANTENNA GAIN: <u>35 DBi</u> , BEAMWIDTH: <u>2.76 deg</u> , AZIMUTHAL RANGE: <u>000-360</u> , THE SITE ELEVATION ABOVE MEAN SEA LEVEL IN METERS <u>10 m</u> , THE ANTENNA HEIGHT ABOVE TERRAIN IN METERS <u>2.2 m</u> , RAD = 35G003B001-360A00010H002	EXAMPLE ASSUMING NONGEOSTATIONARY, 16 DBI GAIN, 30 DEGREE BEAMWIDTH, AZIMUTHAL RANGE FROM 001-360, SITE ELEVATION OF 357 METERS, AND ANTENNA HEIGHT ABOVE TERRAIN OF 6 METERS: RAD01 16G030B001-360A00357H006

Receive Antenna Additional Information (For Parabolic Antennas)	ANTENNA DIAMETER: <u>3.7m</u> , ANTENNA EFFICIENCY: <u>0.55</u> ,	
Number of Satellite Contacts Supported Per Day	1	NUMBER OF TIMES THE SATELLITE WILL COMMUNICATE WITH THE EARTH STATION IN THE SPACE TO EARTH DIRECTION (DOWNLINKS) EACH DAY
Expected Duration of Each Contact	<u>7 min</u>	AVERAGE DURATION OF EACH CONTACT
Supported Operations	Satellite Health and Status Data ☒ Mission Payload Data ☒	SATELLITE HEALTH AND STATUS TELEMETRY AND/OR MISSION PAYLOAD DATA
FCC notes:		

X- Band [Awarua, New Zealand]		
State (RSC)	RSC = Awarua	
City Name (RAL)	RAL = New Zealand	
Latitude (DDMMSS)	Lat = 463141S	
Longitude (DDMMSS)	Lon = 1682245W	
Receive Antenna Polarization (RAP)	RAP = T	POLARIZATIONS INCLUDE: H = HORIZONTAL, V = VERTICAL, S = HORIZONTAL AND VERTICAL, L = LEFT HAND CIRCULAR, R = RIGHT HAND CIRCULAR, T = RIGHT AND LEFT HAND CIRCULAR, J = LINEAR POLARIZATION

Receive Antenna Orientation (RAZ)	RAZ = V00 <i>(Az: 0 deg to 360 deg)</i>	THE EARTH STATION RECEIVER ANTENNA MINIMUM OPERATING ANGLE OF ELEVATION (RAZ), V00 TO V90, EXAMPLE, RAZ01 V00
Receive Antenna Dimensions (RAD)	ANTENNA GAIN: <u>35 DBi</u> , BEAMWIDTH: <u>0.6 deg</u> , AZIMUTHAL RANGE: <u>000-360</u> , THE SITE ELEVATION ABOVE MEAN SEA LEVEL IN METERS <u>10 m</u> , THE ANTENNA HEIGHT ABOVE TERRAIN IN METERS <u>2.2 m</u> , RAD = 35G001B001-360A00010H002	EXAMPLE ASSUMING NONGEOSTATIONARY, 16 DBI GAIN, 30 DEGREE BEAMWIDTH, AZIMUTHAL RANGE FROM 001-360, SITE ELEVATION OF 357 METERS, AND ANTENNA HEIGHT ABOVE TERRAIN OF 6 METERS: RAD01 16G030B001-360A00357H006
Receive Antenna Additional Information (For Parabolic Antennas)	ANTENNA DIAMETER: <u>3.7m</u> , ANTENNA EFFICIENCY: <u>0.55</u> ,	
Number of Satellite Contacts Supported Per Day	1	NUMBER OF TIMES THE SATELLITE WILL COMMUNICATE WITH THE EARTH STATION IN THE SPACE TO EARTH DIRECTION (DOWNLINKS) EACH DAY
Expected Duration of Each Contact	<u>7 min</u>	AVERAGE DURATION OF EACH CONTACT
Supported Operations	Satellite Health and Status Data ☒ Mission Payload Data ☒	SATELLITE HEALTH AND STATUS TELEMETRY AND/OR MISSION PAYLOAD DATA
FCC notes:		

Part B: Ground Stations, Earth to Space link data

Earth Station Transmitter Data (Required for Each Frequency at Each Earth Station Location)

S-Band [Shetland, UK]		
State (XSC)	XSC = United Kingdom	
City Name (XAL)	XAL = Shetland	
Latitude (DDMMSS)	Lat = 604454N	
Longitude (DDMMSS)	Lon = 005130W	
Transmit Power (PWR)	PWR = 31.62 W	TRANSMIT POWER SUPPLIED TO THE ANTENNA INPUT TERMINAL, EXAMPLE, PWR01 W2 TRANSMIT POWER UNITS INCLUDE: W = WATT, K = KILOWATT, M = MEGAWATT
Necessary Bandwidth	600 kHz	THE WIDTH OF FREQUENCY BAND WHICH IS JUST SUFFICIENT TO SUCCESSFULLY TRANSFER DATA. FORMULAS CAN BE FOUND IN ANNEX J OF THE NTIA MANUAL.
RF Emissions Data		2-SIDED EMISSION BANDWIDTH VALUES
-3 dB bandwidth	276.5	
-20 dB bandwidth	579.8	
-40 dB bandwidth	1208.2	
-60 dB bandwidth	2883.8	
Modulation Type	QPSK	THE METHOD USED TO SUPERIMPOSE DATA ON THE CARRIER, EXAMPLE, BPSK, QPSK, GMSK.
Data Rate	960 kbps	INFORMATION DATA RATE
Forward Error Correction Coding	Is FEC used? Yes ☒ No ☐ FEC Type: <u>Reed-Solomon</u> , <u>Convolutional Coding</u> $\frac{1}{2}$	
Total Symbol Rate	4801 kSps	DATA RATE COMBINED WITH FEC AND FRAME OVERHEAD RESULTING IN THE TOTAL SYMBOL RATE AT THE INPUT TO THE SYMBOL MAPPER/MODULATOR.
Transmit Antenna Polarization (XAP)	XAP = T	POLARIZATIONS INCLUDE: H = HORIZONTAL, V = VERTICAL, S = HORIZONTAL AND VERTICAL, L = LEFT HAND CIRCULAR, R = RIGHT HAND CIRCULAR, T = RIGHT AND LEFT HAND CIRCULAR, J = LINEAR POLARIZATION

S-Band [Shetland, UK]		
Transmit Antenna Orientation (XAZ)	XAZ = V00	THE EARTH STATION TRANSMITTER ANTENNA MINIMUM OPERATING ANGLE OF ELEVATION (XAZ), V00 TO V90, EXAMPLE, XAZ01 V00
Transmit Antenna Dimensions (XAD)	ANTENNA GAIN: <u>35 DBi</u> , BEAMWIDTH: <u>2.76 deg</u> , AZIMUTHAL RANGE: <u>000-360</u> , THE SITE ELEVATION ABOVE MEAN SEA LEVEL IN METERS <u>19 m</u> , THE ANTENNA HEIGHT ABOVE TERRAIN IN METERS <u>2.2m</u> , XAD = 35G003B001-360A00019H002	EXAMPLE ASSUMING NONGEOSTATIONARY, 16 DBI GAIN, 30 DEGREE BEAMWIDTH, AZIMUTHAL RANGE FROM 001-360, SITE ELEVATION OF 357 METERS, AND ANTENNA HEIGHT ABOVE TERRAIN OF 6 METERS: XAD01 16G030B001-360A00357H006
Transmit Antenna Additional Information (For Parabolic Antennas)	ANTENNA DIAMETER: <u>3.7m</u> , ANTENNA EFFICIENCY: <u>0.55</u> ,	
Number of Satellite Contacts Supported Per Day	1	NUMBER OF TIMES THE EARTH STATION WILL COMMUNICATE WITH THE STATELLITE IN THE EARTH TO SPACE DIRECTION (UPINKS) EACH DAY
Expected Duration of Each Contact	<u>7 min</u>	AVERAGE DURATION OF EACH CONTACT

S-Band [Chile, Punta Arenas]		
State (XSC)	XSC = Chile	
City Name (XAL)	XAL = Punta Arenas	
Latitude (DDMMSS)	Lat = 530230S	
Longitude (DDMMSS)	Lon = 0705049W	
Transmit Power (PWR)	PWR = 31.62 W	TRANSMIT POWER SUPPLIED TO THE ANTENNA INPUT TERMINAL, EXAMPLE, PWR01 W2 TRANSMIT POWER UNITS INCLUDE: W = WATT, K = KILOWATT, M = MEGAWATT
Necessary Bandwidth	600 kHz	THE WIDTH OF FREQUENCY BAND WHICH IS JUST SUFFICIENT TO SUCCESSFULLY TRANSFER DATA. FORMULAS CAN BE FOUND IN ANNEX J OF THE NTIA MANUAL.
RF Emissions Data		2-SIDED EMISSION BANDWIDTH VALUES
-3 dB bandwidth	276.5	
-20 dB bandwidth	579.8	
-40 dB bandwidth	1208.2	
-60 dB bandwidth	2883.8	

S-Band [Chile, Punta Arenas]		
Modulation Type	QPSK	THE METHOD USED TO SUPERIMPOSE DATA ON THE CARRIER, EXAMPLE, BPSK, QPSK, GMSK.
Data Rate	960 kbps	INFORMATION DATA RATE
Forward Error Correction Coding	Is FEC used? Yes ☒ No ☐ FEC Type: <u>Reed-Solomon</u> , <u>Convolutional Coding</u> $\frac{1}{2}$	
Total Symbol Rate	4801 kSps	DATA RATE COMBINED WITH FEC AND FRAME OVERHEAD RESULTING IN THE TOTAL SYMBOL RATE AT THE INPUT TO THE SYMBOL MAPPER/MODULATOR.
Transmit Antenna Polarization (XAP)	XAP = T	POLARIZATIONS INCLUDE: H = HORIZONTAL, V = VERTICAL, S = HORIZONTAL AND VERTICAL, L = LEFT HAND CIRCULAR, R = RIGHT HAND CIRCULAR, T = RIGHT AND LEFT HAND CIRCULAR, J = LINEAR POLARIZATION
Transmit Antenna Orientation (XAZ)	XAZ = V00	THE EARTH STATION TRANSMITTER ANTENNA MINIMUM OPERATING ANGLE OF ELEVATION (XAZ), V00 TO V90, EXAMPLE, XAZ01 V00
Transmit Antenna Dimensions (XAD)	ANTENNA GAIN: <u>35 DBi</u> , BEAMWIDTH: <u>2.76 deg</u> , AZIMUTHAL RANGE: <u>000-360</u> , THE SITE ELEVATION ABOVE MEAN SEA LEVEL IN METERS <u>36 m</u> , THE ANTENNA HEIGHT ABOVE TERRAIN IN METERS <u>3.2m</u> , XAD = 35G003B001-360A00036H003	EXAMPLE ASSUMING NONGEOSTATIONARY, 16 DBI GAIN, 30 DEGREE BEAMWIDTH, AZIMUTHAL RANGE FROM 001-360, SITE ELEVATION OF 357 METERS, AND ANTENNA HEIGHT ABOVE TERRAIN OF 6 METERS: XAD01 16G030B001-360A00357H006
Transmit Antenna Additional Information (For Parabolic Antennas)	ANTENNA DIAMETER: <u>3.7m</u> , ANTENNA EFFICIENCY: <u>0.55</u> ,	
Number of Satellite Contacts Supported Per Day	1	NUMBER OF TIMES THE EARTH STATION WILL COMMUNICATE WITH THE STATELLITE IN THE EARTH TO SPACE DIRECTION (UPINKS) EACH DAY
Expected Duration of Each Contact	<u>7 min</u>	AVERAGE DURATION OF EACH CONTACT

S-Band [Blönduós, Iceland]		
State (XSC)	XSC = Blönduós	
City Name (XAL)	XAL = Iceland	
Latitude (DDMMSS)	Lat = 653850N	
Longitude (DDMMSS)	Lon = 0201442W	
Transmit Power (PWR)	PWR = 31.62 W	TRANSMIT POWER SUPPLIED TO THE ANTENNA INPUT TERMINAL, EXAMPLE, PWR01 W2 TRANSMIT POWER UNITS INCLUDE: W = WATT, K = KILOWATT, M = MEGAWATT
Necessary Bandwidth	600 kHz	THE WIDTH OF FREQUENCY BAND WHICH IS JUST SUFFICIENT TO SUCCESSFULLY TRANSFER DATA. FORMULAS CAN BE FOUND IN ANNEX J OF THE NTIA MANUAL.
RF Emissions Data		2-SIDED EMISSION BANDWIDTH VALUES
-3 dB bandwidth	276.5	
-20 dB bandwidth	579.8	
-40 dB bandwidth	1208.2	
-60 dB bandwidth	2883.8	
Modulation Type	QPSK	THE METHOD USED TO SUPERIMPOSE DATA ON THE CARRIER, EXAMPLE, BPSK, QPSK, GMSK.
Data Rate	960 kbps	INFORMATION DATA RATE
Forward Error Correction Coding	Is FEC used? Yes ☒ No ☐ FEC Type: <u>Reed-Solomon</u>, <u>Convolutional Coding ½</u>	
Total Symbol Rate	4801 kSps	DATA RATE COMBINED WITH FEC AND FRAME OVERHEAD RESULTING IN THE TOTAL SYMBOL RATE AT THE INPUT TO THE SYMBOL MAPPER/MODULATOR.

S-Band [Blönduós, Iceland]		
Transmit Antenna Polarization (XAP)	XAP = T	POLARIZATIONS INCLUDE: H = HORIZONTAL, V = VERTICAL, S = HORIZONTAL AND VERTICAL, L = LEFT HAND CIRCULAR, R = RIGHT HAND CIRCULAR, T = RIGHT AND LEFT HAND CIRCULAR, J = LINEAR POLARIZATION
Transmit Antenna Orientation (XAZ)	XAZ = V00	THE EARTH STATION TRANSMITTER ANTENNA MINIMUM OPERATING ANGLE OF ELEVATION (XAZ), V00 TO V90, EXAMPLE, XAZ01 V00
Transmit Antenna Dimensions (XAD)	ANTENNA GAIN: <u>35 DBi</u>, BEAMWIDTH: <u>2.76 deg</u>, AZIMUTHAL RANGE: <u>000-360</u>, THE SITE ELEVATION ABOVE MEAN SEA LEVEL IN METERS <u>55 m</u>, THE ANTENNA HEIGHT ABOVE TERRAIN IN METERS <u>2.5 m</u>, XAD = 35G003B001-360A00055H003	EXAMPLE ASSUMING NONGEOSTATIONARY, 16 DBI GAIN, 30 DEGREE BEAMWIDTH, AZIMUTHAL RANGE FROM 001-360, SITE ELEVATION OF 357 METERS, AND ANTENNA HEIGHT ABOVE TERRAIN OF 6 METERS: XAD01 16G030B001-360A00357H006

S-Band [Blönduós, Iceland]		
Transmit Antenna Additional Information (For Parabolic Antennas)	ANTENNA DIAMETER: <u>3.7m</u> , ANTENNA EFFICIENCY: <u>0.55</u> ,	
Number of Satellite Contacts Supported Per Day	1	NUMBER OF TIMES THE EARTH STATION WILL COMMUNICATE WITH THE STATELLITE IN THE EARTH TO SPACE DIRECTION (UPINKS) EACH DAY
Expected Duration of Each Contact	<u>7 min</u>	AVERAGE DURATION OF EACH CONTACT

S-Band [Awarua, New Zealand]		
State (XSC)	XSC = Awarua	
City Name (XAL)	XAL = New Zealand	
Latitude (DDMMSS)	Lat = 463141S	
Longitude (DDMMSS)	Lon = 1682245W	
Transmit Power (PWR)	PWR = 31.62 W	TRANSMIT POWER SUPPLIED TO THE ANTENNA INPUT TERMINAL, EXAMPLE, PWR01 W2 TRANSMIT POWER UNITS INCLUDE: W = WATT, K = KILOWATT, M = MEGAWATT
Necessary Bandwidth	600 kHz	THE WIDTH OF FREQUENCY BAND WHICH IS JUST SUFFICIENT TO SUCCESSFULLY TRANSFER DATA. FORMULAS CAN BE FOUND IN ANNEX J OF THE NTIA MANUAL.
RF Emissions Data		2-SIDED EMISSION BANDWIDTH VALUES
-3 dB bandwidth	276.5	
-20 dB bandwidth	579.8	

S-Band [Awarua, New Zealand]		
-40 dB bandwidth	1208.2	
-60 dB bandwidth	2883.8	
Modulation Type	QPSK	THE METHOD USED TO SUPERIMPOSE DATA ON THE CARRIER, EXAMPLE, BPSK, QPSK, GMSK.
Data Rate	960 kbps	INFORMATION DATA RATE
Forward Error Correction Coding	Is FEC used? Yes ☒ No ☐ FEC Type: <u>Reed-Solomon</u> , <u>Convolutional Coding 1/2</u>	
Total Symbol Rate	4801 kSps	DATA RATE COMBINED WITH FEC AND FRAME OVERHEAD RESULTING IN THE TOTAL SYMBOL RATE AT THE INPUT TO THE SYMBOL MAPPER/MODULATOR.
Transmit Antenna Polarization (XAP)	XAP = T	POLARIZATIONS INCLUDE: H = HORIZONTAL, V = VERTICAL, S = HORIZONTAL AND VERTICAL, L = LEFT HAND CIRCULAR, R = RIGHT HAND CIRCULAR, T = RIGHT AND LEFT HAND CIRCULAR, J = LINEAR POLARIZATION
Transmit Antenna Orientation (XAZ)	XAZ = V00	THE EARTH STATION TRANSMITTER ANTENNA MINIMUM OPERATING ANGLE OF ELEVATION (XAZ), V00 TO V90, EXAMPLE, XAZ01 V00

S-Band [Awarua, New Zealand]		
Transmit Antenna Dimensions (XAD)	ANTENNA GAIN: <u>35 DBi</u>, BEAMWIDTH: <u>2.76 deg</u>, AZIMUTHAL RANGE: <u>000-360</u>, THE SITE ELEVATION ABOVE MEAN SEA LEVEL IN METERS <u>10 m</u>, THE ANTENNA HEIGHT ABOVE TERRAIN IN METERS <u>2.2 m</u>, XAD = 35G003B001-360A00010H002	EXAMPLE ASSUMING NONGEOSTATIONARY, 16 DBI GAIN, 30 DEGREE BEAMWIDTH, AZIMUTHAL RANGE FROM 001-360, SITE ELEVATION OF 357 METERS, AND ANTENNA HEIGHT ABOVE TERRAIN OF 6 METERS: XAD01 16G030B001-360A00357H006
Transmit Antenna Additional Information (For Parabolic Antennas)	ANTENNA DIAMETER: <u>3.7m</u>, ANTENNA EFFICIENCY: <u>0.55</u>,	
Number of Satellite Contacts Supported Per Day	1	NUMBER OF TIMES THE EARTH STATION WILL COMMUNICATE WITH THE STATELLITE IN THE EARTH TO SPACE DIRECTION (UPINKS) EACH DAY
Expected Duration of Each Contact	<u>7 min</u>	AVERAGE DURATION OF EACH CONTACT

S-Band Satellite Receive Specifications		
Receive Antenna Polarization (RAP)	RAP = R	POLARIZATIONS INCLUDE: H = HORIZONTAL, V = VERTICAL, S = HORIZONTAL AND VERTICAL, L = LEFT HAND CIRCULAR, R = RIGHT HAND CIRCULAR, T = RIGHT AND LEFT HAND CIRCULAR, J = LINEAR POLARIZATION
Receive Antenna Orientation (RAZ)	RAZ = NB	NB= NARROWBEAM EC = EARTH COVERAGE
Receive Antenna Dimension (RAD)	ANTENNA GAIN <u>4.4 dBI</u> , BEAMWIDTH: <u>80 deg</u> , RAD = 4G480B	NTIA FORMAT(RAD), EXAMPLE, FOR 16 DBI ANTENNA GAIN AND 30 DEGREE BEAMWIDTH RAD01 16G030B
Type of satellite (State = SPCE) City = Geo or Nongeo	Type = NONGEOSTATIONARY	CHOOSE EITHER: GEOSTATIONARY OR NONGEOSTATIONARY
For Geostationary Satellites	N/A	IF ANY SATELLITES ARE GEOSTATIONARY, REPORT ITS LATITUDE AS 000000N (XLA AND/OR RLA) AND REPORT ITS LONGITUDE IN DDDMMSS FORMAT (XLG AND/OR RLG).

S-Band Satellite Receive Specifications		
For Nongeostationary (Orbital Data)	INCLINATION ANGLE: <u>97.6 DEG</u>, APOGEE IN KILOMETERS: <u>550 KM</u>, PERIGEE IN KILOMETERS: <u>550 KM</u>, ORBITAL PERIOD IN HOURS: <u>1</u> AND FRACTIONS OF HOURS IN DECIMAL: <u>0.6</u>, THE NUMBER OF SATELLITES IN THE SYSTEM: <u>1</u>, ORB = *ORB,97.6IN00550AP0055 0PE001.6H01NRT01	IF ANY SATELLITES ARE NONGEOSTATIONARY, REPORT ITS INCLINATION ANGLE, APOGEE IN KILOMETERS, PERIGEE IN KILOMETERS, ORBITAL PERIOD IN HOURS AND FRACTIONS OF HOURS IN DECIMAL, THE NUMBER OF SATELLITES IN THE SYSTEM, THEN T01, EXAMPLE, REM04 *ORB,98.0IN00510AP00510PE001.58H01NRT01 , AND FOR SPACE-TO-SPACE COMMUNICATIONS WITH ANOTHER NONGEOSTATIONARY SATELLITE ADD AN ADDITIONAL *ORB FOR IT ENDING IN R01, EXAMPLE, REM05 *ORB,72.9IN03209AP00655PE013.46H01NRR0 1
For SunSynchronous Nongeostationary Orbits	Mean Local Time of Ascending Node (MLTAN) = <u>22:30</u>	MLTAN IS THE ANGLE BETWEEN AN ORBIT'S ASCENDING NODE AND THE MEAN SUN, OFTEN EXPRESSED AS UNIT OF TIME (HH:MM)